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Mechanick Dialling:

Or, the

New Art of Shadows:

Freed from the many

Obſcurities, *Superfluities* and *Errors*

Of *Former* Writers upon this Subject.

The whole laid down after ſo *plain* a Method that *any* Perſon

(tho' a Stranger to the Art)

With a Pair of COMPASSES and Common RULER *only*,

May make a *Dial* upon any *Plane* for any Place in the WORLD, as well as thoſe who have attained to the greateſt *Knowledge* and *Perfection* in the *Mathematicks*.

Illuſtrated with *many* Copper Plates,

And

Examples of *Dials* for *London*, *Exeter*, *Briſtol*, *Worceſter*, *Oxford*, *Cambridge*, *Norwich*, *Lincoln*, *Cheſter*, *Liverpool*, *York*, *Newcaſtle* upon *Tyne*, *Durham*, *Edinburgh*, *Dublin*, &c.

To which are *added*,

1. A choice Collection of *Mottos* in *Latin* and *Engliſh*.
2. A *New* and *Correct* Alphabetical Table of the moſt eminent *Cities*, *Towns*, in the whole World; ſhewing the *Elevation of the Pole*, and the *Difference of their Meridian* from *London*.
3. The beſt and moſt approved Methods of Painting Sun Dials.

A Work not only uſeful for *Artificers*, but very *entertaining* for *Gentlemen*, and thoſe *Students* at the *Univerſities*, that would underſtand *Dialling*, without the *Trouble* of going through a Courſe of Mathematics.

By *CHARLES LEADBETTER*,
Teacher of the Mathematics in *London*.

LONDON:
Printed for EDWARD WICKSTEED at the *Black Swan* in *Newgate-Street*. 1737.

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THE AUTHOR TO THE READER.

SINCE *the Buſineſs of Dialling, if* Mechanically *conſidered, is of itſelf a Thing ſo* natural *and* eaſy, *one would wonder, after ſo much* learned *Buſtle as the* Mathematicians *have made about it, that they ſhould have more* perplexed *and* obſcured *than promoted the Knowledge of that* uſeful *and* entertaining *Art amongſt the* Generality *of Mankind.*

The different Ways, *in which theſe Gentlemen have* hitherto *choſe the World ſhould ſee that* uſeful *Subject handled, would certainly have been right and proper, and liable to no Exception, if* all Men *were* Mathematicians: *But how* few *are ſuch? And therefore their having treated of Dialling in a* Geometrical Inſtrumental *or* Arithmetical *Method, I am ſure cannot poſſible be of* any Uſe *or* Signification *to ſuch as know nothing at all of thoſe Sciences or the* Doctrine of the Sphere.

Certainly, *there are* Two *very different Ends of writing Books, which treat of any Art or Science; the one is to advance the Art or Science itſelf, and the* other *to* inſtruct Learners.

Now, with reſpect to the Former, *the* Extent *and* Capaciouſneſs *of the Subject is chiefly to be regarded; and nothing is to be omitted which properly falls within the Compaſs of the Art or Science treated of; but with reſpect to the* Later *the* Capacities *of the* Learners *are principally to be conſidered, and Notice is to be taken, not of whatever may be known or done by the Art or Science treated of, but only of what is* moſt uſeful, *and withal* moſt eaſy *to be known.*

The moſt proper *and* rational *Method, therefore, to make any one Maſter of any Art or Science, is to introduce it to him after the moſt* plain familiar *and* natural *Method, and to teach him at* firſt *only ſo much of the Art as is really uſeful in* common Life, *and withal moſt eaſy to be underſtood; and when he has gone through, and is become Maſter of what is moſt* uſeful *and* eaſy, *he will be enabled with more Eaſe to conquer the more* difficult *Parts of it, and to purſue the Study of it after a more* learned *Manner, if his own* Inclinations *or* Profeſſion *ſhall incline him ſo to do.*

Upon theſe Conſiderations, and with this View it was that I drew up this Treatiſe of Mechanick Dialling, *becauſe of all thoſe who*

have hitherto treated upon this Subject in the Engliſh Tongue *for* the Inſtruction of Learners, *not one of them ſeems to me to have* thoroughly conſidered, *what I have now premiſed.*

By the Method *I have obſerved in this Treatiſe, the* Length *and* Dryneſs *of the Study of* Dialling *(which has diſcouraged many) is quite removed; and it is now rendered not only* very uſeful, *but* perfectly eaſy *and* entertaining: *And I think without Vanity I may venture to affirm, that by the Help of this Book only, the* Learner *may obtain a competent Knowledge in Dialling, in much leſs* Time, *and with* much leſs Trouble, *than he can by the Aſſiſtance of* any other, *or indeed* all *the Treatiſes which have yet appeared in* Engliſh *upon this Subject: where he will either find the* eaſy and uſeful, *and the* difficult *and* uſeleſs *Elements of this Art* promiſcuouſly *and* injudiciouſly *exhibited and taught* together; *or elſe the Subject treated of after ſuch a manner* as can never be comprehended *by any one that does not underſtand ſome of the* abſtruſeſt *Branches of the* Mathematicks *. *But*

It is high Time that I ſhould now proceed to give the Reader the Particulars of what he may expect to meet with in the following Treatiſe.

---

* *Such as* Geometry, Aſtronomy, *&c.*

In the firſt Place, *he is made Maſter of thoſe few* Geometrical Problems, *which may be of Service to him in* Mechanick Dialling.

Secondly, *I have taught him not only the* Uſe *of the* Quadrant *and* Trigon, *but alſo how to make thoſe* univerſal *Inſtruments, which for their* Simplicity, *and the great Uſe they are of in Dialling are never enough to be valued. I have likewiſe taught him not only the* Uſe *of, but alſo how to make* Dialling Scales, *and this is not to be met with in any other Treatiſe extant upon this Subject.*

Thirdly, *I have given him ſuch* plain *and* ample *Directions, that it will be impoſſible for him to miſcarry in making of a Dial for* any Place in the World, *whether the Dial be* Equinoctial, Horizontal, Erect, Declining Reclining *or* Inclining.

Fourthly, *To theſe I have added* plain *and* eaſy *Directions for making of* Reflective, Refractive *and* Globe Dials.

I have likewiſe taught the Reader how to make a Croſs Dial, *and in this, on account of its* Novelty, *I have been very full and particular, not only in ſhewing him after what manner it muſt be made, but in having the ſeveral* neceſſary *Views or Poſitions of it engraved in Copper. I was tempted to be thus particular, by reaſon I never yet ſaw or heard there was any other Dial of that Sort in* England, *beſides that which I have mentioned in this Treatiſe.*

Fifthly, *I have furnished the Reader with the following very useful and accurate Tables.*

1. *A Table of the* Sun's Declination *exactly calculated for the Year* 1738, *which (for the Use of Dialling) will serve for this Age without any* sensible *Error.*

2. *An* exact *Table of the* Equation of Time *for the Regulating of* Clocks *and* Watches *by a* Sun Dial.

3. *A Table for the Converting of* Hours *and* Minutes *of* Time *into* Degrees *and* Minutes *of the* Equinoctial, *and* è contra.

4. *A Table for Drawing the* Hour Lines *upon all* Horizontal, *&c.* Dials *from the* Equinoctial *to the* Poles.

5. *A Table of the* Three Requisites *in Dialling, shewing the* Substyle's Distance *from the* 12 a Clock *Hour Line*; *the* Style's Height, *and the* Inclination of Meridians *answering to the several Degrees of the* Declination of your Plane.

6. *A Table shewing the* Sun's Altitude *for every* Hour and Quarter *of the Day, at his* Entrance *into the* 12 Signs *of the* Zodiack.

Sixthly, *I have given a* plain *and* familiar *Description of the* Sphere, *for the Sake of such as are inclined to have a true Notion of such* Circles in the Heavens, *as are frequently mentioned in* this *and* other *Books of Dialling.*

Seventhly, *In Chap.* XXIII *is a Collection of* Mottos *for Dials in* Latin *and* English,

ſuitable to almoſt all Places where Dials may be fixed.

Eightly, *And that nothing might be wanting to render this Work compleat, I have added a* new *and* correct *Alphabetical Table of the moſt eminent* Cities, Towns, *&c. in the whole World, ſhewing at* each Place *the* Elevation of the Pole, *and* Difference of their Meridian *from* London, *and this Table may be depended upon to be the* beſt that is extant, *becauſe I have ſpared neither Time nor Pains to correct as many as I could from* celeſtial Obſervations.

Ninthly, *In* Chap. XXVI *I have been very full and particular concerning the manner of* making *and* painting *of* Dial Planes, *and alſo concerning the preparing the different* Colours *and* Oyls *proper for that Purpoſe; and in this I hope to merit the Approbation of thoſe who live in the Country, and cannot upon all Occaſions have the Aſſiſtance of a profeſſed Painter.*

And I have alſo added Chap. XXVII *concerning* Painting Houſes, &c. *being thoroughly convinced that all thoſe* Country Gentlemen, *and* others, *who are inclined to be* good Huſbands, *will think it very well worth their Peruſal.*

Laſtly, *Though it may appear a little foreign to my preſent Purpoſe, yet for the Entertainment of the curious, I have ſhewn (in* Chap. XXV.) *how* naturally *the* Two *Hands*

Hands of a Watch *or* Clock *repreſent the* Motions *of the* Sun *and* Moon.

At the Requeſt of my ingenious Friend Mr Edward Hauxley, *I have added his curious Queſtion in Dialling, with his general Solution, it being till now never anſwered by any one, and I am perſwaded it will be acceptable to the curious Reader.*

And now wiſhing my Reader as much Benefit *from the peruſal of this Treatiſe, as I have had* Pleaſure *in compoſing of it, I remain his faithful Friend whilſt*

London, May
16. 1737.

CHARLES LEADBETTER.

☞ *N. B.* In CHAP. XIX where I treat of a *Window Dial*, I have adviſed you *firſt* to make a Draught of your Dial upon *Paper*; which I take this Opportunity to recommend, as a very good and practical Method; eſpecially if your Dial be for an *Erect Direct*, or *Erect Decliner*, or *Reclining Inclining* Plane: Then, I ſay, (after you have found the *Declination of the Plane*, as taught in *Chap.* X.) procure a large Sheet of thick writing Paper, and thereon make the Draught of your Dial (according to the reſpective Directions for making thoſe Dials) which done, either with *Wax* or a few ſmall *Nails*, faſten your *Paper Draught* to the Plane (which I ſuppoſe to be made ready for that Purpoſe) upon which you deſign to draw the Dial. Having placed *the Center* of your *Paper* Dial in *the very Place* where you deſign to fix the *Style* in the Plane, there faſten a String, and with this String transfer the *Hours* and *Quarters* from your *Paper Draught* to the *Plane*. And this you will find to be a very eaſy, expeditious, and exact Way of drawing the *Hour Lines* and *Quarters* upon any Plane whatſoever.

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And he alſo ſhews Gentlemen or others to Perfection the Satellites of Jupiter, any Evening on which that Planet is Viſible, which has never been done by any other Perſon.

N. B. Thoſe that write to him out of the Country are deſired to pay the Poſtage of their Letters, otherwiſe they may expect no Anſwer.

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A

TABLE

OF THE

CONTENTS.

CHAP. I.

Page

OF Things neceſſary to be known by the Mechanick Dial Maker —— 1

Viz. *To divide a* right Line *into* two *equal Parts* —— —— —— 1

To raiſe a Perpendicular *on the middle of a* right Line —— —— 2

To let fall a Perpendicular *upon a* right Line *from a given Point* above —— 3

To raiſe a Perpendicular *at the* End *of a Line given* —— —— 4

To draw Lines parallel *to each other* 4

To draw Parallel *or* Concentric *Circles* 5

To find a Loſt *Center* —— — 6

Three *Points not in a* right Line *given to make a* Geometric Square —— 7

To make a Line of Chords *to any* Length *or* Radius —— —— — 8

To make a Line *or* Scale *of* Six Hours 9

To

Page
To make a Line *or* Scale *of* Inclination of Meridians —— —— 9
To make a Line *or* Scale *of* Latitudes 10
To make a Quadrant —— —— 11
To make a Trigon —— —— 12

CHAP. II.

Of Dialling *in general* —— —— 15
A new *and* correct *Table of the principal* Cities *and* Towns *in* England, Scotland, Ireland *and* Wales, *shewing at each Place the* Elevation of the Pole, *and* Difference of their Meridian *from* London 16

CHAP. III.

To make an Equinoctial *Dial* —— 17

CHAP. IV.

To make an Horizontal *Dial* —— 20

CHAP. V.

To make an erect direct South *Dial* — 24

CHAP. VI.

To make an erect direct North *Dial* — 27

CHAP. VII.

To make an erect direct East *Dial* — 30

CHAP. VIII.

To make an erect direct West *Dial* — 32

CHAP. IX.

To make a Polar *Dial* —— — 34

CHAP. X.

To find the Declination *of a* Wall *or* Plane *whereon to Draw or Fix a* Sun Dial 36

CHAP. XI.

To make an erect Declining *Dial* —— 38

CHAP.

Page

CHAP. XII.

To make a Dial *upon a* Plane *where the* Pole *has but small Elevation* — 44

CHAP. XIII.

To make a Declining Reclining *Dial* 47

CHAP. XIV.

To make an East *or* West Reclining *Dial* 55

CHAP. XV.

To make a North *or* South *Declining* Reclining *or* Inclining *Dial* —— 61

CHAP. XVI.

To make a Reflective *Dial* —— 66

CHAP. XVII.

To make a Refracted *Dial* —— 73

CHAP. XVIII.

To make a Globe *Dial* —— — 74

CHAP. XIX.

To make a Cross *Dial* — — 78

To make a Window *Dial* — — 82

A Table of the Sun's Declination *exactly calculated* — —— — 85

A Table of the Equation of Time *for* Regulating *Clocks and Watches by the Sun* 89

A Table for converting Hours *and* Minutes *of Time into* Degrees *and* Minutes *of the* Equinoctial, *and for turning of* Degrees *and* Minutes *of the* Equinoctial *into* Hours *and* Minutes *of* Time 93

A Table shewing the Degrees of each Hour Line *from* 12 a-Clock *upon all Horizontal and* North *and* South *Erect Direct*

Page

rect Reclining *and* Inclining *Dials from the* Equinoctial *to the* Poles —— 97

A Table of the Three Requisites *in Dialling, shewing the* Substyle's Distance *from the* Meridian, *the* Style's Height, *and the* Inclination *of* Meridians, *answerable to the several* Degrees of Declinaton *of your* Plane —— 104

A Table shewing the Sun's Altitude *every* Hour and Quarter *of the Day at his Entrance into the* 12 *Signs of the* Zodiack — —— —— —— 110

CHAP. XX.

Shewing the Use of the Scales *in Plate* 2 113

Examples of Dials made by the Dialling Scales —— —— — 115

Shewing the Use of the Trigon —— 117

CHAP. XXI.

A Review of the Equinoctial, *and Direct* East *and* West *Dials* —— 121

CHAP. XXII.

A Description of the Sphere —— 125

CHAP. XXIII.

A Collection of Mottos *for Dials in* Latin *and* English —— —— 130

CHAP. XXIV.

A new *and* correct *Alphabetical Table of the most eminent* Cities, Towns, *&c. in the World, shewing at each Place* the Elevation of the Pole, *and the* Difference

Page
ference of their Meridian *from* London — — — — 134

CHAP. XXV.

Concerning the Motion *of the* Two *Hands of a Watch or Clock as it represents the Motion of the* Sun *and* Moon — 164

CHAP. XXVI.

Of Painting Sun Dials, *and of* making *the Planes or Surfaces upon which they are to be drawn* — — 167

CHAP. XXVII.

Of the Manner of Painting Timber Work, *&c.* — — — 185

N. B. *The* DIALS *for the* following *Places are to be found upon the* oppoſite *Pages.*

Cambridge 48
Cheſter — 25
Conſtantinople 116
Cronton —— 38
Durham —— 21
Dublin —— 75
Edinburgh — 61
Exeter — — 33
Leverpool — — 38
Lincoln — — 49
London 44 *and* 113
Norwich — — 50
Newcaſtle — 51
Ormſkirk —— 68
Oxford —— 30
Port Royal — 117
Penzance — 114
Shrewſbury — 53
St Thomas Iſland 34
Worceſter — 57
Warrington — 38
Wrexham — 52
York —— 28

Mechanick

OF
Mechanick Dialling.

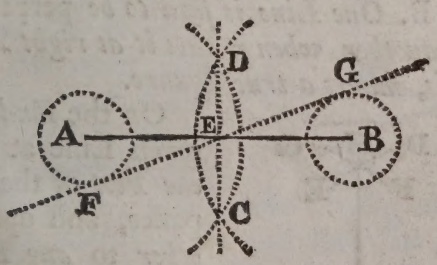
CHAP. I

CHAP. I.

Treats of things neceſſary to be known by the Mechanick Dial-maker.

PROB. I.

TO *divide a* right Line *given* (*as* A B) *into* two *equal Parts.*



Open your Compaſſes to any extent *more* than *half* the *Length* of the Line A B; ſet one Foot in A, and deſcribe the *Arch* B D C,

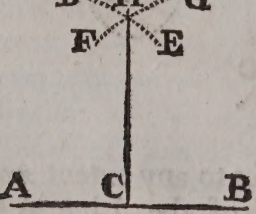
CHAP. I.

D C, then with the *ſame Extent* of the Compaſſes, ſet one foot at B, and deſcribe the *Arch* D C on the other Side: where theſe two Arches *croſs* each other, lay a Ruler, and draw the *right Line* D C, and it will divide the right Line *given* in E, the *middle* thereof: *or* the ſame given right Line may be divided into *two equal Parts*, by ſetting one Foot of the Compaſſes on the *end* of the Line at A, and there deſcribe the dotted Circle, and then with the *ſame Extent* of the Compaſſes, draw the *other* dotted Circle at B; laſtly, draw the right Line F G, and it will divide the given right Line A B in E, as before.

PROB. II.

To erect *or* raiſe *a* Perpendicular, *on the* middle *of a given* right Line.

N. B. *One Line is ſaid to be* perpendicular *to another, when it cuts it at right Angles, that is, makes a true Square.*



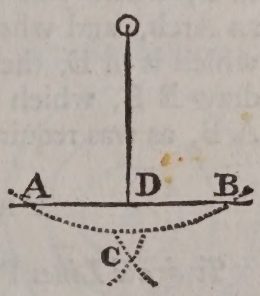
On the *End* of the given Line at A, ſet *one Foot* of the Compaſſes, and open the *other* to *any Extent*, more than *half* the *Length* of the Line, and deſcribe the Arch D E; with the *ſame Extent* ſet *one Foot* of the

the Compaſſes at B, and draw the Arch F G; lay a Ruler to C, *the Middle* of the given Line, and to the *Croſſing of* the *two Arches*, and draw C H, which will be *perpendicular* to A B, as was required. CHAP. I.

PROB. III.

To let fall *a* Perpendicular *as* ⊙ D *upon a right Line, from a given Point above.*

Let *the Point above* be ⊙, and the given right Line A B; ſet one Foot of your Compaſſes in ⊙, and extend the other Foot to A, and deſcribe the Arch A B; ſet one Foot of the Compaſſes in A, where the Arch cuts the given Line, and draw an Arch at C, with the *ſame* Extent; then ſet one Foot in B, *viz.* where the Arch cuts the Line, and draw another little Arch at C; lay a Ruler to the given Point ⊙, and to the *Croſſing* of the two little Arches at C, and draw the Line, ⊙ D, ſo it will be at right Angles to A B, as was required.

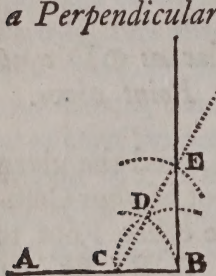


CHAP. I.

PROB. IV.

To erect a Perpendicular *at the* End *of a given Line.*

Let the given right Line be A B, and from the End B, let it be required how to *erect a Perpendicular*, as B E; open your Compasses to any convenient Distance as B C and draw the Arch C D; lay a Ruler to C and D, and draw the dotted Line C D E as long as you please, take the Distance C D in your Compasses, and set from D to E, where you may if you please strike an Arch, and where it cuts the Line C E which is in E, there lay a Ruler to B, and draw B E, which shall be *perpendicular* to A B, as was required.



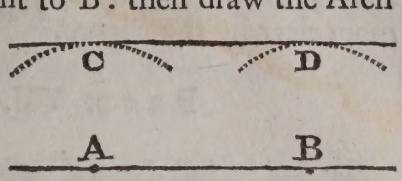
PROB. V.

To draw Lines Parallel *to each other.*

Parallel Lines are those that being continued ever so far will never meet.

Let the Line given be A B, unto which I would draw a parallel Line: open your Compasses to any *convenient* Distance, and set one Foot in A, draw an Arch at C, and carry

carry *this* Extent to B: then draw the Arch at D, lay a Ruler to touch the Arch C and D, and draw the right Line C D, which is parallel to A B, as was required. CHAP. I.

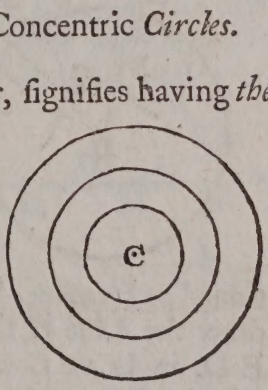


N. B. There is a Ruler sold at the Mathematical Instrument-makers, which greatly supplies the use of this Problem, known by the Name of the *Parallel Ruler*, which I recommend to all my Readers as very useful.

PROB. VI.

To draw Parallel, *or* Concentric *Circles.*

The Word *Concentric*, signifies having *the same* Center, and several Circles drawn from the same Center, are said to be *concentric*: therefore set one Foot of your Compasses in C, the *Center*, and open the other Foot to the Distance of your Circle intended, and draw a Circle; keep the Foot of your Compass in the same Center, and open the other to the Distance of *another* Circle; which draw,

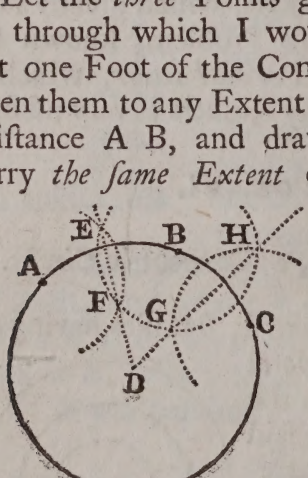


CHAP. I. and do so by as many as you intend, as is more clear by the Figure.

PROB. VII.

To find a lost Center, *which is the* same *as to find a* Center *that will pass through* any three Points *not in* a right Line.

Let the *three* Points given be A B and C, through which I would draw a Circle. Set one Foot of the Compasses at A, and open them to any Extent *more than half* the Distance A B, and draw the Arch E F; carry *the same Extent* of the Compasses,



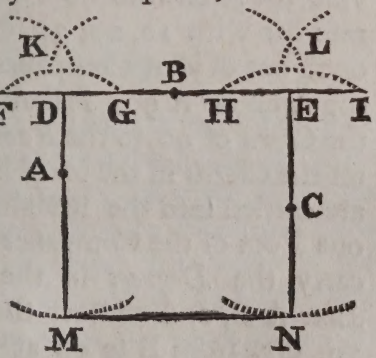
and set one Foot in B; draw the Arch E G H, with the *same* Extent; set one Foot in C, and draw the Arch H G; lay a Ruler to E F, and draw the Line E D continued at Pleasure; lay a Ruler to H G, and draw the Line H D, and it will meet with E D, in D *the Center* of the Circle, from which Center draw a Circle with the Distance D A, and it will pass thro' the three given Points A B C, as was required.

PROB.

PROB. VIII.

Three Points *not in a* right Line, *given to make a* Geometric Square.

Let the *three Points* given be A, B, C; thro' the Point B draw, the Line F I, ſet one Foot of the Compaſſes in the Point A, and draw the Arch F G; ſet one Foot of the Compaſſes in the Point C, and draw the Arch H I; ſet one Foot of the Compaſſes in H and I *ſeverally*, and draw the the two Arches at L; ſet one Foot in F and G *ſeverally*, and draw the two Arches at K; lay a Ruler to L and C, and draw a Line *with the point of your Compaſſes*; lay a Ruler to K and A, and draw another Line *with the point of your Compaſſes*; then take D E in your Compaſſes, and ſet one Foot thereof in D and E *ſeverally*, and draw the Arches at M and N, and where thoſe Arches *cut* that Line drawn with the *point* of your Compaſſes, *that* determines the length of the Lines D M, and E N, which draw *with Ink* and 'tis done.



CHAP. I.

PROB. IX.

To make a Line of Chords *to any assigned* Radius *or* Length.

Plate 2. Fig. 1.

Radius in Geometry signifies *half* the *Diameter* of any Circle *Equal* to C B; and the *Chord* of an *Arch*, is like the string of a Bow: *i. e.* it is a Line drawn from *any Point* in the Circumference of a Circle, to *any other Point* in the same Circle, as the Lines B 10, B 20, B 30, B 40, B 50, B 60, B 70, B 80, B 90, are the Chords of their respective Arches.

First, draw the *Quadrant* B C 90, and divide the Arch into 90 *Equal* Parts, which number with 10, 20, 30, *&c.* to 90 *Deg.* set one Foot of your Compasses in B, and draw the Arch 90 A 90; so shall the Line A B be the *Chord* of 90, to the *Radius* C B; (because all the *Chords* in the *Arch* B. 10, 20 and 90. are carried into the streight Line A. B.) set one Foot of the Compasses again in B, and carry the *Degrees* in the *Arch* into the *Line* A B, and number them with 10, 20, 30, *&c.* from B to 90 at A, so shall you have a *Line of Chords*, and thus may you make one of what Length you please.

PROB.

PROB. X.

To draw a Line, or Scale of six Hours.

Plate 2. Fig. 2

With any *convenient* opening of the Compasses draw the *Quadrant* A B C, divide the *Arch* into *six* equal Parts, and draw the *Chord* A C; lay a Ruler to the *Center* B, and to *every* Division in the Arch, and it will divide the *Chord* A C into a Scale of Six Hours, see the Figure.

PROB. XI.

To make a Scale of Inclination of Meridians.

Plate 2. Fig. 3.

With the same *Radius*, or opening of the Compasses that you drew the *Quadrant* of the Scale of the Six Hours, draw the *Quadrant* A B C, divide the Arch into *nine* equal Parts, and every one of them into *ten*, so will the *Quadrant* be divided in 90 *equal* Parts, or Degrees; then draw the *Chord* A C; lay a Ruler to the *Center* B, and to *every* Division in the Arch, and it will divide the *Chord* A C into *a Scale of Inclination of Meridians*,

CHAP. I. *Meridians, equal* to that of the *Scale of six Hours.*

PROB. XII.

To make a Line, *or* Scale *of* Latitudes.

Plate 2. Fig. 4.

To proportion this Scale to the *other two* last mentioned, *the Scale of Latitudes* must be the *Chord* of 60 *Deg.* to the *same Circle* in which the *Scale of six Hours* is the *Chord* of 90 *Deg.*

In either of the Problems X or XI, set one Foot of the Compasses in B, and take the *nearest* Distance to the *Chord* A C, with *that* Extent draw the *Semicircle* D I F, and divide the *Quadrant* D I into 90 *equal Parts* or *Degrees*, and number them with 10, 20, 30, *&c.* to 90, then by *Prob.* V. or rather with your *Parallel Ruler*, draw the Lines 10 *a*, 20 *c*, 30 *e*, *&c. parallel* to D E; lay a Ruler to D, and to *a*, *c*, *e*, *g*, *i*, *l*, *p*, and I *severally*, and draw D *a b*, D *c d*, D *e f*, D *g h*, D *i k*, D *l m*, D *n o*, D *p q*, and D I, and setting one Foot of the Compasses in F, *carry* the Points *b*, *d*, *f*, *h*, *k*, *m*, *o*, *q*, and I, into the Line F G, and number it with 10, 20, 30, 40, 50, 60, 70, 80, 90, which shall be a *Line of Latitudes* to the *given Radius*. *Lastly*, *carry*

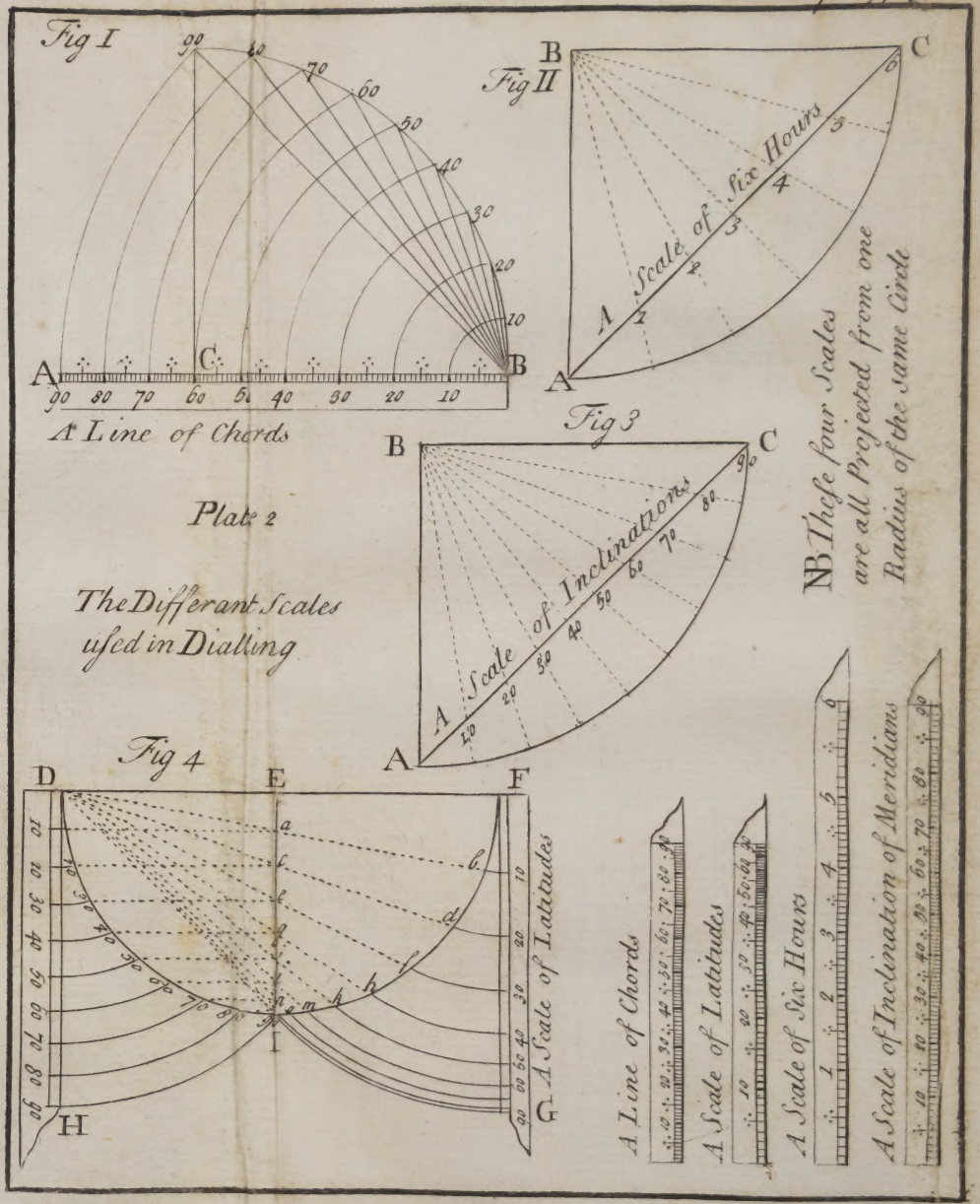


Fig I
A Line of Chords
Fig II
A Scale of six Hours
Fig 3
A Scale of Inclinations
NB These four Scales are all Projected from one Radius of the same Circle
Plate 2
The Differant Scales used in Dialling
Fig 4
A Scale of Latitudes
A Line of Chords
A Scale of Latitudes
A Scale of Six Hours
A Scale of Inclination of Meridians

carry the Points 10, 20, 30, 40, 50, 60, 70, 80, 90, in the Arch D I, into the Line D H, and that ſhall be a *Line of Chords*, anſwering the *Line of Latitudes*, *Inclination of Meridian* and *Hours*. CHAP. I.

PROB. XIII.

To make a Quadrant.

A QUADRANT, is a very uſeful Inſtrument in Dialling, and is the *fourth Part* of a Circle, of any opening of your Com-

paſſes, whatever you pleaſe: The *Limb*, or *Arch* thereof, is divided into 90 *equal Parts*, called *Degrees*, and numbred with 10, 20, 30, *&c.* to 90. It has on one *Edge* two Sights, as the annexed Figure. There are two

CHAP. I. two Sorts commonly sold in *London*, known by the Names of *Gunter*'s and *Collins*'s Quadrants, which have Lines of *Hours* and *Azimuth*, drawn on the *Face*, to shew the *Hour* of the Day or Night, and the *Azimuth*, of the Sun, at any time, for the Latitude of *London* only.

N. B. If you buy either of these Quadrants, and take them far *North* or *South* from *London*, they will there be of no Service to you in finding the *Hour* and *Azimuth*, but only in taking an *Altitude*, and other Purposes in Dialling, as will be shewn in its proper Place. Those that would draw the *Hours* and *Azimuths* on a Quadrant to any *particular* Latitude, may have Recourse to my *System of Astronomy*, VOL. I. where they will find full Directions for those Purposes.

If you procure a good seasoned Board that will not warp, and thereon paste a Sheet of good Paper, and draw such a *Quadrant* as above represented, and fix thereto a *Thread* and *Plummet*, it will serve your purpose well enough.

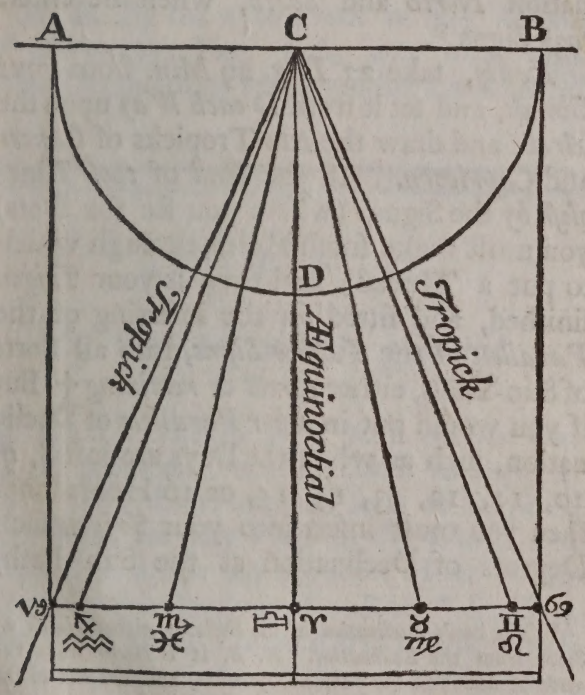
PROB. XIV.

To make a Trigon.

The TRIGON is likewise a very useful Instrument in Dialling, and may be made upon a thin Board, or Sheet of good Paste-Board,

Board, as is the Figure A B ♋ ♈, of any convenient Size you pleaſe. At right Angles to A B, draw C D ♈, which ſhall repreſent the *Equinoctial:* with the *Chord* of 60 Degrees, draw the *Semicircle* A D B; Take in your Compaſſes from the Line of *Chords* (Plate 2. Fig. 1.) 11 *Deg.* 30 *Min.* (for ſuch is the Sun's Declination when he enters ♉ ♍ North, and ♎ ♓ South,) and ſet one Foot in the

CHAP. I.



Point D, that is where the *Equinoctial* C D ♈, cuts the *Semicircle*, and turn the other Point

each

CHAP. I. *each way* upon the Arch, there make Marks, and draw C ♉ ♍, and C ♏ ♐: Theſe two Lines ſhall repreſent the *Sun's Declination* in the *Trigon*, when he enters *thoſe Signs*. Take 20 *Deg.* 11 *Min.* from your *line of Chords*, (Plate 2. Fig. 1.) and ſet it from D, *each Way* upon the *Arch*, and thro' *thoſe* Points draw C ♊ ♌, and C ♑ ♒, theſe *two* Lines in the *Trigon* ſhall repreſent the Sun's Declination *North* and *South*, when he enters *thoſe* Signs *.

Laſtly, take 23 *Deg.* 29 *Min.* from your *Chords*, and ſet it from D *each Way* upon the *Arch*, and draw the *two* Tropicks of *Cancer* and *Capricorn*. At the *End* of *thoſe* Lines *cloſe by* the Signs, (where you ſee the Dots) you muſt make ſmall Holes, through which to put a Thread; and thus is your *Trigon* finiſhed, and fitted for the inſerting of the *Parallels* of the *Twelve Signs*, into all Sorts of Sun-Dials, either *direct* or *reclining* †. But if you would put in *other Parallels* of Declination, ſuch as when the Days are juſt 8, 9, 10, 11, 12, 13, 14, 15, or 16 Hours long, then you muſt inſert into your *Trigon* ſuch Degrees of Declination as the Sun hath,

* The Sun's *Declination* is his *Diſtance* either *North* or *South* from the *Equinoctial*. *N. B.* It is *North* from the 10th of *March* to the 12th of *September*, and the reſt of the Year it is *South*. See Table I.

† The *Parallels* of the 12 *Signs* are the Sun's Declination that Day that he enters any *Sign*; as for Example *Taurus* 11 Deg. 30 Min. as you find it in Table I.

when

when the Days are so many Hours long, as you would describe upon your Dial: and so in the Latitude of *London*,

				Deg.	*Min.*	
when the day is either	8 9 10 11	or	16 15 14 13 Hours long the sun hath	21 16 11 5	40 55 37 55	Of Declination.

N. B. By the 25th Prob. of my *System of Astronomy*, Pag. 146, you may find these Declinations for any other Latitude.

CHAP. II.

Of DIALLING *in general.*

DIALLING is a very *curious* and *useful* Art, and teacheth us how to draw *Hour-Lines* upon all sorts of *Surfaces*, or *Planes*, for any Place in the World, and thereby to know the apparent Hour of the Day, by the Shadow of a *Style* * fixed on the Plane *parallel to the Earth's Axis*, which *Style* can have no more than *three* Positions, *viz.*

Dialling what.

* The *Style* in Dialling, signifies the Pin or Cock of a Dial, the Shadow of which points out the Hour.

CHAP. II.

viz. Perpendicular, Oblique and *Parallel*, which shall be shewn in their proper Places †.

The various *Position* of the *Style or Gnomon of a Dial.*

The *Dial-Planes*, on which Hour-Lines are drawn, are these following.

The different Sort of *Dial-Planes.*

- The Horizontal
- The North and South erect direct
- The erect Decliner
- The Reclining Inclining
- The Reclining Declining
- The Convex
- The Concave

} Dial-Plane.

Of the *Equinoctial* Dial, *and why first treated of.*

The *Equinoctial* Dial-Plane, is that which is *parallel* to the Plane of the *Earth's Equator*, and is *universal*, for Hour Lines drawn thereon, will shew the apparent Time of the Day in any Place of the World; and because this is the *Ground* and *Foundation* of all other Dials, therefore I shall begin *first* with it, and in the Course of this Work shall shew how naturally the *Hour-Lines* upon all Sorts of Dial-Planes, are deduced from the *Equinoctial* Dial.

† The whole Business of Dialling may be reduced to *three* general Heads; the *first* consists in finding the Place of the *Substyle*, or where the *Style* is to be placed; The *second* in drawing the *Hour-Lines:* and the *third* and last, if the Dial-Plane be *moveable*, in duly placing and fixing the same, after that the Dial is drawn thereon; or else, if the Plane whereon the Dial is to be drawn, be *unmovable* and already fixt, in finding the *Position* or Situation of the said Plane, *viz.* whether it be a *Direct* or *Declining* Plane; and if the *latter*, how far it *declines*.

CHAP.

A new correct *alphabetical Table of the principal* CITIES *and* TOWNS *in* England, Scotland, Ireland, *and* Wales *, *ſhewing at each Place the* Elevation of the Pole, *and* Difference of their Meridians *from* London.

☞ The *Elevation of the Pole* ſignifies the ſame as the *Latitude of the Place*, and the *Difference of Meridians* the ſame as the *Longitude of the Place.*

Note,

D, H, M ſignifies *Degrees, Hours, Minutes*

E, W, N, S ſignifies East, West *Longit.*; North, South *Latit.*

England.	*Latitude.* D.	M.		*Diff. Merid.* H.	M.	
Bedford	52	8	N	0	2	W
Berwick	55	47		0	6	
Briſtol	51	30		0	11	
Buckingham	51	56		0	4	
Bath	51	21		0	10	

* There is a Table of the moſt eminent *Cities* and *Towns* in the WORLD at Page 136.

CHAP. 2.

	Latit. D. M	*Dif.Mer.* H. M
Cambridge	52 17 N	o o
Canterbury	51 18 N	o 5 E
Carlile	54 56 N	o 11 W
Chicheſter	50 56 N	o 2 W
Cheſter	53 12 N	o 12 W
Colcheſter	51 55 N	o 4 E
Coventry	52 26 N	o 6 W
Cronton *in* Lancaſhire	53 22 N	o 12 W
Derby	52 55 N	o 6 W
Dorcheſter	50 46 N	o 10 W
Durham	54 48 N	o 6 W
Dover	51 10 N	o 6 E
Exeter	50 44 N	o 14 W
Falmouth *in* Cornwall	50 9 N	o 22 W
Flamborough	54 7 N	o 1 E
Glouceſter	51 53 N	o 9 W
Guilford	51 14 N	o 3 W
Hull	53 46 N	o 1 W
Hertford	51 48 N	o o W
Hereford	52 4 N	o 11 W
Huntington	52 19 N	o 1 W
Harborough, Leiceſterſhire	52 30 N	o 5 W
Ipſwich	52 10 N	o 5 E
Kendal	54 14 N	o 11 W
Lancaſter	54 5 N	o 11 W
Leiceſter	52 37 N	o 5 W
Lincoln	53 12 N	o 2 W
London	51 32 N	o o
Liverpool	53 22 N	o 12 W

Litchfield

	Latit.		*Dif. Mer.*		CHAP.
	D. M		H. M		2.
Litchfield	52 43	N	0 8	W	
Mancheſter	53 32	N	0 9	W	
Northampton	52 50	N	0 6	W	
Norwich	52 43	N	0 6	E	
Nottingham	52 58	N	0 4	W	
Newcaſtle *upon* Tyne	54 57	N	0 6	W	
Oxford	51 45	N	0 5	W	
Orfordneſs	52 12	N	0 6	E	
Ormſkirk	53 30	N	0 12	W	
Peterborough	52 33	N	0 2	W	
Penzance, Cornwall	50 8	N	0 24	W	
Portſmouth	50 45	N	0 5	W	
Preſton, Lancaſhire	53 42	N	0 11	W	
Richmond, Yorkſhire	54 25	N	0 6	W	
Rocheſter, Kent	51 25	N	0 3	E	
Saliſbury	51 4	N	0 8	W	
Shrewſbury	52 44	N	0 11	W	
Stafford	52 50	N	0 9	W	
Stamford Line	52 37	N	0 2	W	
Southampton	50 55	N	0 6	W	
Truro	50 19	N	0 22	W	
Wigan	53 34	N	0 11	W	
Weymouth	50 36	N	0 11	W	
Warwick	52 18	N	0 6	W	
Winchelſea	50 54	N	0 3	E	
Wincheſter, Hants	51 3	N	0 5	W	
Wolverhampton	52 38	N	0 9	W	
Worceſter	52 14	N	0 9	W	
Woodſtock	51 53	N	0 6	W	
Warrington	53 22	N	0 10	W	

CHAP. 2.

	Latit. D. M	*Dif.Mer.* H.M
Wells, Somerſet	51 11 N	0 11 W
York	53 55 N	0 4 W
Yarmouth, Norfolk	52 46 N	0 7 E

Wales.

Beaumaris	53 18 N	0 17 W
Brecknock	52 0 N	0 13 W
Bangor, Biſhop's See	53 21 N	0 17 W
Cardigan	52 10 N	0 19 W
Carmarthen	51 52 N	0 18 W
Carnarvan	53 10 N	0 18 W
Cardiff	51 32 N	0 13 W
Denbigh	53 11 N	0 14 W
Harlech *in* Merioneth-ſhire	52 55 N	0 17 W
Flint	53 14 N	0 13 W
Landaff	51 33 N	0 13 W
Monmouth	51 50 N	0 11 W
Montgomery	52 34 N	0 13 W
Milford	51 43 N	0 20 W
Pembroke	51 45 N	0 20 W
Radnor	52 21 N	0 12 W
St Davids	52 1 N	0 22 W
St Aſaph	53 18 N	0 14 W
Wrexham	53 6 N	0 13 W
Welſhpool	52 40 N	0 12 W

Britiſh

	Latit. D. M	Dif.Mer. H.M
British Islands.		
Angleſey Middle	53 20 N	0 18 W
Guernſey	49 36 N	0 11 W
Jerſey	49 28 N	0 14 W
Lundy	51 20 N	0 15 W
Man	54 25 N	0 18 W
Portland	50 30 N	0 11 W
Wight	50 37 N	0 6 W
Yarmouth in Ditto	50 41 N	0 7 W
Scotland.		
Aberdeen	57 6 N	0 6 W
Dunbar	56 7 N	0 9 W
Dundee	56 30 N	0 10 W
Dunblain	56 18 N	0 16 W
Dunkel	56 39 N	0 13 W
Edinburgh	56 7 N	0 12 W
Glaſgow	55 50 N	0 17 W
Leith	55 58 N	0 12 W
Orkney	60 6 N	0 14 W
St Andrews	56 23 N	0 10 W
Stirling	56 12 N	0 15 W
Ireland.		
Antrim	54 44 N	0 27 W
Arglas	54 19 N	0 24 W
Ardmagh	54 20 N	0 28 W
Belfaſt	54 36 N	0 27 W

Caterlagh

CHAP. 2.

	Latit. D. M		*Dif.Mer.* H.M	
Caterlagh	52 48	N	0 29	W
Clare	52 41	N	0 37	W
Cork	51 45	N	0 38	W
Colerain	55 8	N	0 29	W
Drogheda	53 49	N	0 27	W
Dublin	53 20	N	0 28	W
Dundalk	54 4	N	0 28	W
Galloway	53 10	N	0 40	W
Kenny	52 39	N	0 30	W
Kildare	53 11	N	0 29	W
Kingſale	51 31	N	0 38	W
Londonderry	54 55	N	0 32	W
Lymerick	52 22	N	0 39	W
Mariborrow	53 0	N	0 31	W
Philipſton	53 15	N	0 31	W
Tuam	53 26	N	0 37	W
Waterford	52 12	N	0 30	W
Wexford	52 20	N	0 27	W
Youghall	51 51	N	0 33	W

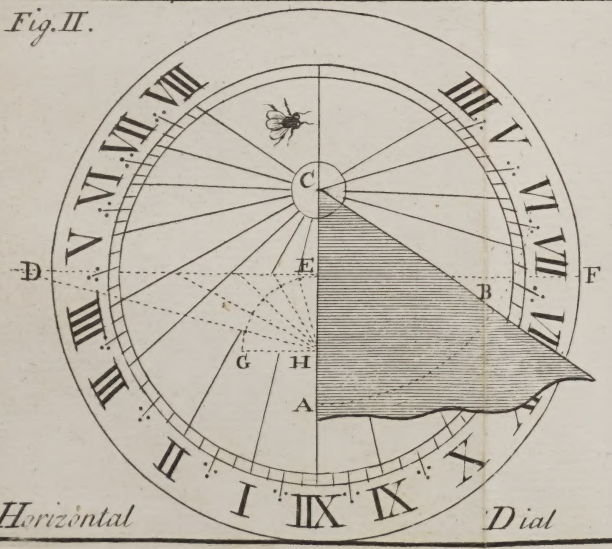
CHAP.

to Fold out Facing page 17

Fig. I. Plate 3

An Equinoctial Universal Dial

Fig. II.



Horizontal Dial

CHAP. III.

CHAP. III.

To make an EQUINOCTIAL * *Dial.*

Plate 3. Fig. 1.

The Equinoctial *Dial* the most easy and useful.

THIS Dial of all others, is the most simple and easy to be drawn, and is thus made.

Take a *flat* Plate of Brass, about a Foot square; or if you cannot easily procure Brass, get a piece of good dried Oak well planed on both sides.

For the Hour Lines.

Draw with your Compasses *three* † *Concentrick Circles* thereon, to contain the Figures, which divide into 24 *equal Parts*; then lay a Ruler to the *Center*, and draw Lines to those *equal Divisions* in the *Circle*, and they shall be the true *Hour Lines* sought.

For the Style.

Erect in the *Center* of the Plate a Pin or Wire *perpendicular* to the Plane, as A B,

* *Equinoctial Dials* are those whose *Plane* or *Face* lieth parallel to the Equinoctial.

† See Problem 6. Page 5.

CHAP. III.

and that shall be the *Style* truly fitted to the Dial.

15 *Deg.* in the *Equinoctial* equal to *one Hour* in Time.

You must observe that 15 *Deg.* ‖ in the *Equinoctial* is *one Hour in Time*, as you may see more at large by Table III; and therefore if you take 15 *Deg.* from your *Line of Chords*, and set it off from the 12 *a-clock Line each way*, that will give you the Hours of 11 and 1, and 30 *Deg.* will give you the Hours of 10 and 2, *&c.* and thus the whole *Equinoctial Circle* will be divided into 24 *equal Parts* or *Hours*, as above.

How to make this Dial serve for the whole Year.

But because this Dial when thus drawn on *one* surface *or side* of the Plane, will serve only for one half of the Year, *viz.* while the Sun is on *one side* of the *Equinoctial*, to wit, from the 10th of *March* to the 12th of *September*; and therefore to make it serve for the *whole Year*, it must be *doubly* drawn, *i. e.* on the *lower*, as well as on the *upper side* or surface of the Plane, and then the Wire which serves for the *Style* must go through the *Center*, and must extend itself 6 or 8 Inches more or less *beyond* the surface of the Plane, and stand at *right Angles* therewith; *and then is that Dial*

Of the Style.

‖ Throughout this Book you will find continual mention made of *Degrees* and *Minutes*, therefore you are to remember that a *Degree* is the 360th part of any Circle; *each* of which Degrees is supposed to be divided into 60 Minutes; so that 45 Minutes is *three Quarters* of a Degree, 30 Minutes *half* a Degree, and 15 Minutes a *Quarter* of a Degree, *&c.* See Table III.

finished.

niſhed. How naturally the *Hour Lines* of CHAP. ll Dials are drawn from the *Equinoctial* III. *Dial* is ſhewn in Chapter XXI.

To ſet this Dial truly.

You muſt raiſe the Wire which repre- ents the *Style* to the *Latitude* of your Place, y applying that edge of your *Quadrant* in hich the Sights are fixed to the *Style*, and hen the *Thread* cuts the *Limb* in the *De- rees* of the *Latitude* of *your Place*, then oth the *Style* point to the *Poles of the Vorld*, and the Dial itſelf *lieth parallel* to he *Equinoctial Circle* in the Heavens: But ill here wants *a true* 12 *a-clock Hour Line*, hich muſt be found as I ſhall ſhew in the ext Chapter, and then placing the Dial, o that at 12 *a-clock* the *Shadow* of the *Style* ay fall in the 12 *a-clock Hour Line*, that ou find by the Directions following; and hus will your Dial be *truly placed*, which ou may faſten by fixing two Pieces of Iron t each end of your 12 *a-clock Hour Line* pon your *Dial Poſt*, and in thoſe put the *tyle* of the Dial to the *height*, which was ound before by the help of your *Quadrant*.

CHAP. IV.

CHAP. IV.

To make an HORIZONTAL * *Dial.*

Plate 3. Fig. 2.

The Horizontal *Dial the most useful of* all *Dials.*

THIS is the most *useful* Dial of all others, because the Sun stayeth upon it from his *Rising* to his *Setting in all Places* of the World, wheresoever you be.

Not material what *Form* the Plane is of,

It matters not what Form the Plane on which you would draw an *Horizontal Dial* is, whether it be *Round*, *Square*, or *Triangular*, but they are generally drawn round as on Plate 3. Figure 2. in which when you have drawn *three Concentric Circles*, as a margin to contain the Figures; draw the Line C A which shall represent the 12 *a-clock Line*, and also the *Substylar Line*, in which make choice of a Point, as at C a little above the *Center*, (for by that means you will inlarge the distances of the *Hour Lines*) and through it draw the Line VI. C. VI. for the 6 *a-clock* Hour Line. In the *substylar Line* † as at E, make choice of *another Point*, and through that at *right Angles*

(*which is the* Center *of an Horizontal Dial.*

* *Horizontal Dials* are those whose *Plane or Face* lies *parallel* to the *Horizon* of the Place.

† The *Substylar Line* in Dialling is that Line drawn upon the Plane or Face of the Dial, *over which the Style stands perpendicular*

les to the 12 *a-clock Line* draw the *Line* D E F; having proceeded thus far, let it be required to make an *Horizontal* Dial to the Latitude of *Durham*, which is 54 Deg. 48 Min. *North:* open your Compaſſes to the *Chord of* 60 Deg. ſet one Foot in C, draw the *Arch* A B, and take the *Chord* of 54 Deg. 48 Min. and ſet it from A to B, and draw the Line C B for the *Style*, ſo is A C B, the true form and ſhape of your *Dial-Cock* or *Style*, ſet one Foot of your Compaſſes in E, that is where the Line D E F cuts the 12 *a-clock Line*, and take the neareſt diſtance to the Line C B, or *Style's Height*, turn that point of your Compaſſes about, and make another mark in the 12 *a-clock Line* at H; this point H repreſents the *Center* of the Equinoctial. On H *as a Center*, draw the *Quadrant* G E, and divide it into *ſix equal Parts*, lay a Ruler to H, and to thoſe *equal Parts* in the Arch *ſeverally*, and where the Ruler *cuts* the *Line* D E F the Points are through which the *Hour-Lines* muſt paſs, lay a Ruler to the *Center* at C, and to thoſe marks in the Line D E F, and draw the *Hour-Lines:* ſet off the *ſame* diſtances in the *Line* D E F, from E towards B, and draw the *Morning Hours*; thoſe *before ſix* in the Morning and *after ſix* at Night are

CHAP. IV.

Example of an Horizontal *Dial for* Durham.

Of the Style.

Of the *Hour-Lines.*

pendicular or at *right Angles*. *Note*, This is not the 12 *a-clock Line* in all Dials, tho' it is in the *Horizontal* and *South* and *North Erect Direct* Dials.

CHAP. IV.

drawn by continuing the *ſame Hour Line beyond the Center* C.

How to ſet it truly.

How to ſet it *truly.*

The Dial being thus finiſhed, the next thing is *to ſet it truly*, for if it be ever ſo truly made, and not well ſet, it will go wrong: therefore you muſt firſt ſee that your Poſt on which the Dial is to ſtand be truly level every way: which you may try by your *Quadrant*, on which draw *a Circle* as large as the top of the Poſt will bear; in the *Center* thereof place a Pin *exactly upright*; in the *Forenoon* when the Sun ſhineth let the *end of the Shadow* of the Pin touch the *Circle*, where *make a Mark*; let things ſtand thus till *Afternoon* the ſame *Day*, and then obſerve where the *Top* of the Shadow of the Pin toucheth the ſame Circle; there again *make a ſecond Mark*; then divide the diſtance of theſe *two* Marks into *two equal Parts*, and from *that* through the *Center* draw a Line, which ſhall be the 12 *a-clock Hour Line*, and ſet the 12 *a-clock Line* of your Dial upon this 12 *a-clock Line on the Poſt*; ſo ſhall your Dial be truly placed, which may be faſtened at your own Diſcretion.

Note, Inſtead of the *Quadrant* G E, you may draw a *Semicircle* on the *Center* H, and

and divide it into 12 *equal Parts*, and so Lines drawn from the *Center* at H will give the Points in the *Line* D E F as before. *Or*, if you apply the *Center* of the *Equinoctial Dial* to the *Center* at H, the *Hour Lines* on the *Equinoctial Dial* will cut the *Line* D E F in the Points where the *Hour Lines* on the *Horizontal Dial* must pass. CHAP. IV.

N. B. *For drawing the* half Hours *and* Quarters *upon all Sorts of Dials whatever*, you are to observe, *that as you divided the Circle which represented the* Equinoctial *(into* 24 equal Parts) *for the* Hours, *so you are to divide* each *of those Parts into* 4 equal Parts more, *and those will be the* Quarters.

N. B. *That in* placing *of Dials when made (excepting the* Equinoctial *and* Horizontal Dial) *you have no occasion to regard the Place where they are to be fixed, for the* Hour Lines *being drawn according to the* Declination *or* Reclination *of the Place, it gives you the* true Situation *of the Dial itself.*

CHAP. V.

CHAP. V.

*To make an erect * direct* SOUTH *Dial.*

Plate 4. Fig. 2.

An *erect direct South* Dial, what.

THIS *Dial Plane* is no more than an *upright* Wall which *exactly* faces the true *South* Point. As the *Elevation of the Pole* above the *Horizontal Plane* was *equal to the Latitude of the Place*; so in this it is the *Complement of the Latitude* of the Place (or what it wants to make it up 90 Degrees).

Upon this Dial, the Sun continues *just* 12 *Hours*; that is, from *six* in the *Morning*, till *six* at *Night*, *in all Latitudes.*

* 1. Those *Planes* are said to be *erect* or *upright* which stand *perpendicular* to the *Horizon of the Place*; and such are the Walls of Churches, Houses, or the like, against which for the most part Dials are placed. 2. Of these *erect* or *upright Planes* there are *two* sorts, *viz. Direct* and *Declining*. 3. Those *erect* or *upright Planes* are said to be *direct* which *directly* face the East, West, North or South *Points* of the *Horizon*, and these are called *erect direct Planes*. 4. Those *erect* or *upright Planes* are said to *decline*, which do not *directly* face the East, West, North or South Points, but look upon some *other Points* situate betwixt them, *viz. South-East*, *North-West*, *North-East*, &c. and these *Planes* are called *Upright* or *Erect*, DECLINING *Planes*. How *the Declination* is to be found, is taught in Chapter X.

For

CHAP. V.

For the Hour-Lines.

How to draw the *Hour Lines.*

When you have made choice of your Plane, draw the *Horizontal Line* VI VI, for the *Eaſt* and *Weſt* Line, or *Hour Line* of *Six*; from A let fall the *Perpendicular* A F, for the 12 *a-clock Hour Line*; then with your Compaſſes take 60 *Deg.* from the *Line of Chords*, and draw the *Arch* B C VI; take the *Complement of the Latitude* of your Place (which in this Example I'll ſuppoſe to be *Cheſter*) whoſe *Latitude* as you find it in the Table is 53 Deg. 12 Min. *North*, and ſet 36 Deg. 48 Min. its *Complement*, or what it wants to make it up 90 Degrees from B to C; draw A C for the *height of the Style*. Make choice of any Point at Pleaſure, in the 12 *a-clock Line*, as I; through I at *right Angles* to the 12 a-clock Line, draw the Line D I E; ſet one foot of your Compaſſes in I and take the *neareſt diſtance* to the *height of the Style* A C, and turn that point of your Compaſſes down to F, and there make a Mark in the 12 *a-clock Line*; on which Point F, deſcribe the *Semicircle* G I H, and divide it into 12 *equal Parts* (for that *Semicircle* repreſents *one Half* of the *Equinoctial*;) lay a Ruler to F, and to *thoſe Marks* in the *Semicircle* juſt now made, and draw Lines from thence to the *Line* D I E: Laſtly, draw Lines from A to *thoſe Marks*

Example of an erect direct *South* Dial for *Cheſter.*

CHAP. V.

Marks in the *Line* D I E, and they ſhall be the true *Hour-Lines* upon your Dial's Plane.

For the Quarters.

The *Quarters* are drawn in like manner, by dividing the *Semicircle* into 48 *equal Parts*, ſo that *one* Quarter will be 3 *Deg.* 45 *Min. two* Quarters 7 *Deg.* 30 *Min.* and *three* Quarters will be 11 *Deg.* 15 *Min.* as you may ſee by Table III.

Having thus finiſhed the *Hour Lines*, place 12 at the *end* of the Line A F, and if it is a *South Dial* (as ſpecified above) and your Face toward it, you muſt place the *Morning Hours* on the *left hand*, and the *Afternoon Hours* on the *right*, as you ſee done in the Figure.

For the Style.

How to place the *Style.*

If your Plane be large, it will be beſt to get an iron Rod about the *Thickneſs* of your *Hour Lines* for the *Style*, and be ſure to place it exactly over the 12 *a-clock Hour Line*, and to make an Angle with your Plane equal to the *Complement of Latitude*; which is done by applying the edge of your Quadrant to it, and ſo fix it, when you find it ſtands true.

For

CHAP. VI.

For the Thickneſs *of the* Style.

☞ *Be ſure* you always mind to make Allowance for the *Thickneſs of the Rod* which is to be the *Style*, and this is to be done when you draw the *Semicircle* G I H by having *two Centers* at F diſtant *juſt the Thickneſs of the Style*; otherwiſe if this Care be not taken, your Dial will go too *ſlow* in the *Forenoon*; and too *faſt* in the *Afternoon*.

CHAP. VI.

To make an erect direct NORTH *Dial.*

Plate 4. Fig. 1.

THIS *Dial Plane* is no more than an *upright Wall* that exactly faces the *true North Point*. This Dial is of no uſe from *September* the 12th, to *March* the 10th; that is, while the Sun is in the *ſix Southern* Signs *, to us who inhabit the *Northern Hemiſphere*,

Erect direct North *Dial* what.

The *Six Northern* Signs are,

Aries	♈
Taurus	♉
Gemini	♊
Cancer	♋
Leo	♌
Virgo	♍

* The *Six Southern* Signs are,

Libra	♎
Scorpio	♏
Sagittary	♐
Capricorn	♑
Aquarius	♒
Piſces	♓

CHAP. VI.

misphere, becauſe it only ſhews the Time from *Sun riſing* to *ſix* in the *Morning*, and in the *Afternoon* from *ſix* till *Sun ſetting*; for *this Dial* and the *South Dial*, make up the *Horizontal Dial*, *i. e.* takes in all the Hours of the *longeſt Day*; and as the *Style* of the *South Dial* points *downwards*, ſo of the *North* the *Style* points *upwards*, and makes an *Angle* with the Plane equal to the *Complement of the Latitude* of the Place, *i. e.* what the Latitude of the Place wants to make up 90 Degrees.

Of no Uſe from 12th *September* till 10th *March*. Becauſe it only *ſhews* the Hours *before* ſix in the *Morning*, and the Hours *after* ſix in the *Afternoon*.

The making of this, is the very ſame as the *South Dial*, for having made choice of your Plane, draw the *Horizontal Line* 6, A 6, for the *Eaſt* and *Weſt Line*; *about the middle* at A, erect the *perpendicular* A B, which ſhall repreſent the 12 *a-clock Hour-Line*, (tho' the Figure 12 needs not be put to it).

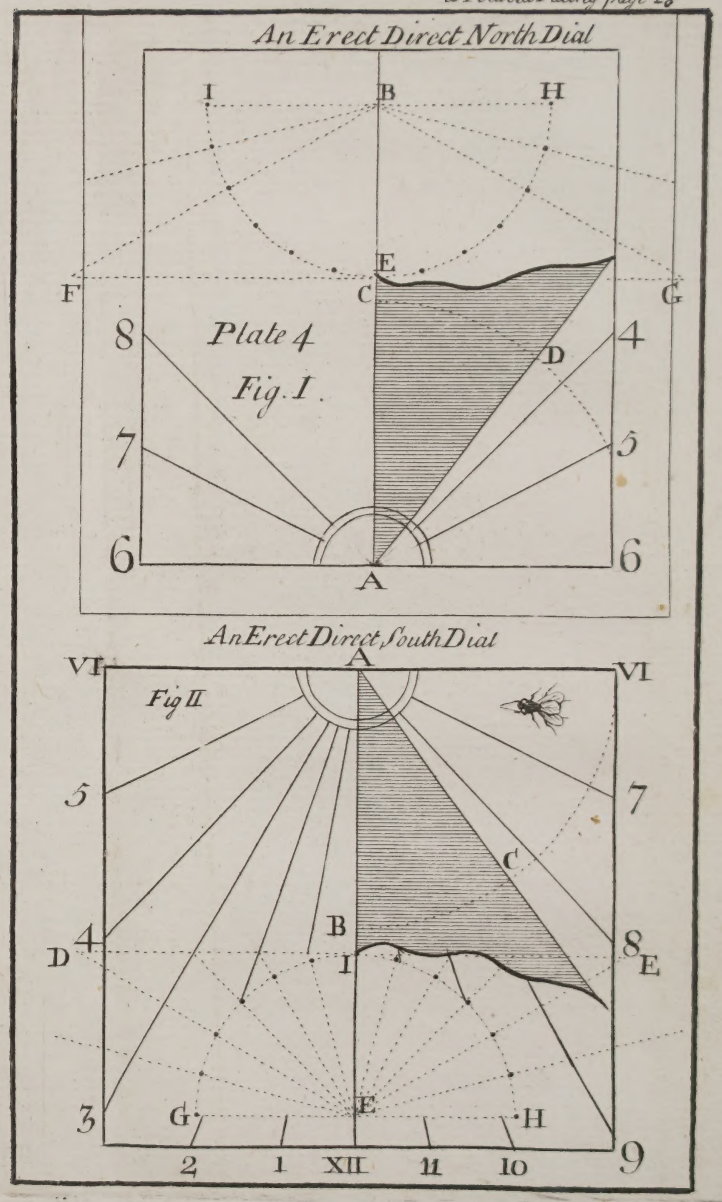
It is made after the ſame manner as the *South Dial*.

For the Style's height.

Example of an erect direct *North* Dial for *York*.

On the Point A, with the *Chord of* 60 *Deg.* draw the Arch C D; take from your Chords the *Complement of Latitude* of your Place, as ſuppoſe *York* 36 Deg. 5 Min. and ſet it from C to D; draw A D for the *Style's height*.

For


An Erect Direct North Dial
I
B
H
E
F
C
G
8
4
Plate 4
Fig. I.
D
7
5
6
6
A
An Erect Direct South Dial
VI
A
VI
Fig II
5
7
C
B
D
4
I
8
E
3
G
E
H
2
1
XII
11
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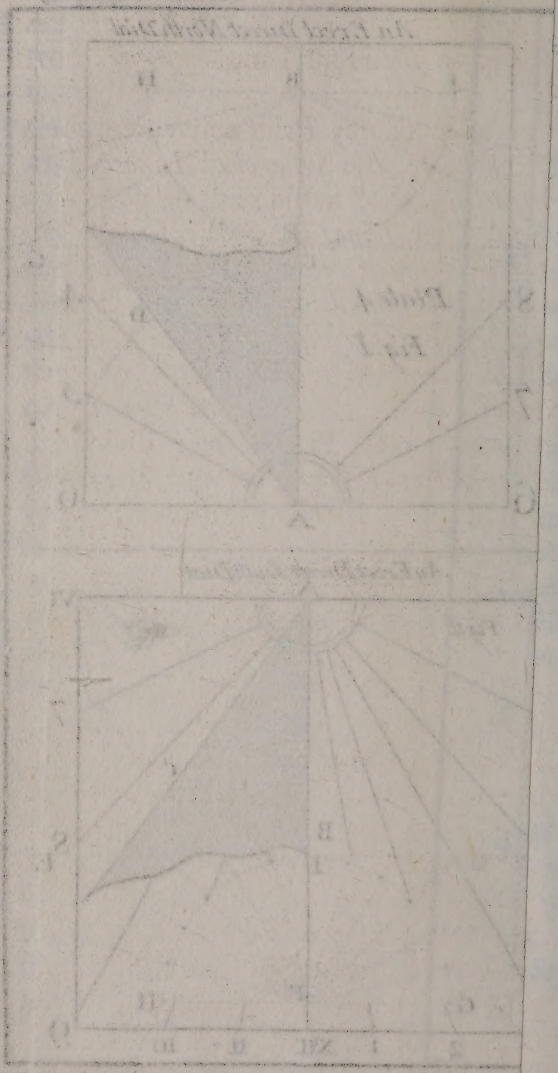


CHAP. VII.

For the Hour Lines.

Make choice of *any Point* convenient for your Purpoſe, in the 12 *a-clock Line* A B, as the Point E; thro' which at *right Angles to the* 12 *a-clock Line*, draw the *Line* F E G; ſet one Foot of your Compaſſes in E, and take the *neareſt diſtance* to the *Style's height* A D; ſet *that diſtance* from E to B, ſo ſhall the *Point* B, be the *Center* of the *Equinoctial*; on B with the *diſtance* B E draw the *Semicircle* H E I, and divide it into 12 *equal Parts*; lay a Ruler to the *Center* B, and to *thoſe* Marks in the *Semicircle*, and where the Ruler cuts the *Line* F E G are the Places where the *Hour Lines* muſt paſs, which muſt be drawn from the *Center* A.

On *this* Dial there is not any occaſion of drawing any more *Hour Lines*, than 4 and 5 in the *Morning*, and 7 and 8 at *Night*.

Over the 12 a-clock Line A B, at *right Angles*, fix the *Style*; ſo that it may make an Angle with the Plane, equal to the *Complement of the Latitude of the Place*; which you muſt try by help of your *Quadrant*, as has been before directed in the *South Dial*; and thus is the *North Dial* compleatly finiſhed. How to place the *Style*.

The *Quarters* and *half Hours* are drawn, as has been taught in *Page* 23 and 26.

CHAP.

CHAP. VII.

CHAP. VII.

To draw an erect direct EAST *Dial.*

Plate 5. Fig. 1.

An erect *direct East Dial* what.

THIS Dial's Plane lieth in the Plane of the *Meridian of the Place*, *i. e.* is no more than *an upright Wall* that exactly faces the *true East Point:* the *Hour Lines* are all *parallel to each other*, and to the *Axis of the World*, and consequently have *no Centers:* the Sun comes on it at his *Rising*, and continues thereon till *near Noon.*

How long the Sun continues on it.

Of the *Substylar Line.*

The *six a-clock Hour Line* is the *Substylar Line*, over which the *Style* is fixed at *right Angles*, and may be either a *thin Plat* of Iron, or a *perpendicular* Wire, *&c.* whose *height* must be equal to the *nine a-clock* Hour Line in this Dial, and to the *three a-clock* Hour Line in the *West* Dial.

How to draw the *Hour Lines.*

Having then made choice of your Plane, *about one third* of the distance from the *bottom*, draw the *Horizontal Line* A C H; in some *convenient Place*, as at C, draw a *Circle* with the *Chord* of 60 *Degrees* sure; then take the *Chord* of the *Latitude of the Place*, as suppose, at *Oxford* 51 *Deg.* 45 *Min.* and set from H to P, and draw P C S, which shall be the *Substylar Line*, and

An Example of an *erect direct East Dial* for *Oxford.*

six

ix a-clock Hour Line; to which at *right* CHAP. *Angles* draw C D for the *Equinoctial.* VII.

Next draw the Line A S B, *parallel* to the *Equinoctial*, and divide the *Quadrant* S D into *ſix equal Parts*; lay a Ruler to the *Center* at C, and to thoſe *equal Parts* in the Circle, and it will cut the *Line* A B in the Points where the *Hour Lines* muſt paſs, through *which Points* in the Line A S B, draw the *Hour Lines parallel* to the *ſix a-clock Hour Line*, which are the true *Hour Lines* from *ſix* till *noon*: the Hours of 4 and 5 in the *Morning*, are the *ſame diſtance from* 6, as 7 and 8 are on the *other ſide.*

The *Quarters* are drawn by ſubdividing the *Diviſions* in the *Circle* into *four* equal Parts, as has been above directed.

Of fixing the Style.

The Hour Lines being thus drawn, fix the *Style* at right Angles on the *Subſtylar Line*, as before directed, and your Dial is compleatly finiſhed.

This Dial is univerſal, by placing the Earth's Axis parallel to the Axis of the World, in what Latitude ſoever you be.

N. B. The Earth's *Axis* in this Dial is repreſented by the *ſix* a-clock Hour Line.

See the Deſcription of the Sphere.

CHAP.

CHAP. VIII.

CHAP. VIII.

To draw an erect direct WEST *Dial*

Plate 5. Fig. 2.

A direct West *Dial* what.

THIS *Dial Plane* is no more than a *upright Wall* that exactly *faces* the *true West Point.*

The making of this is the very same in all respects as making of the *East Dial*, only as the *East* Hour Lines are elevated to the *right hand*, so here they are elevated to the *left hand.*

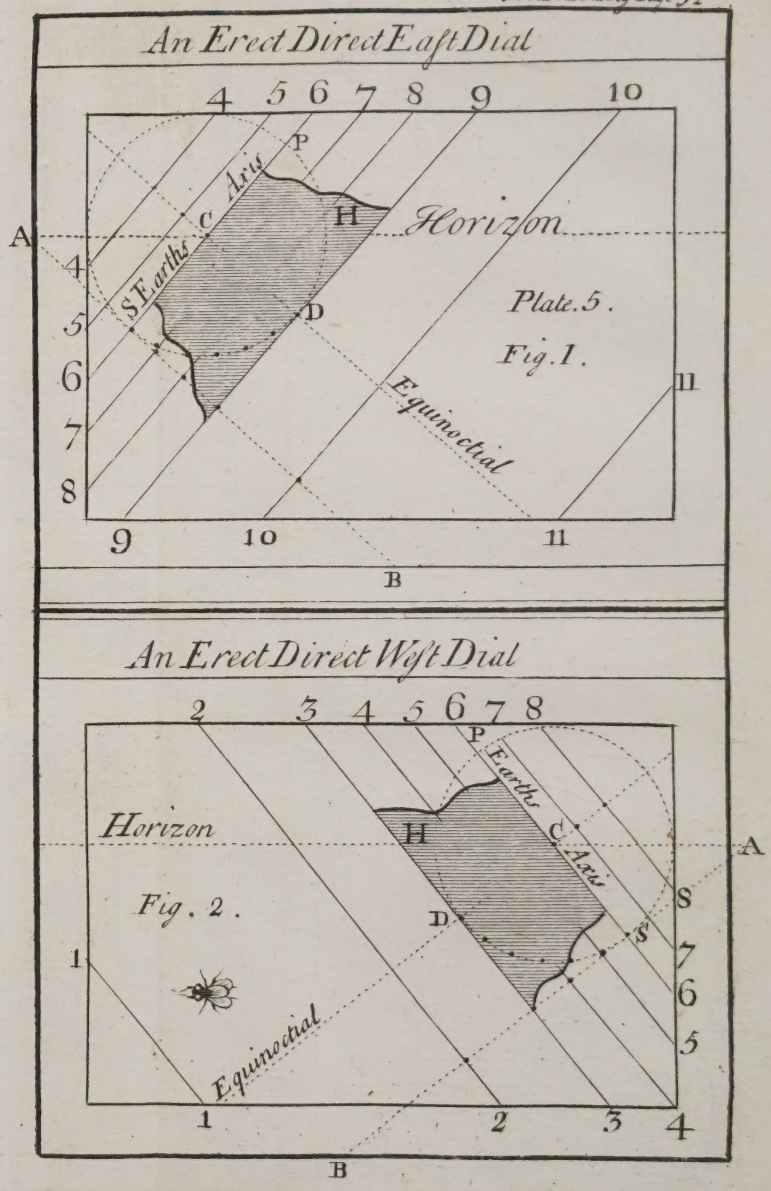
Why 12 a-clock cannot be shewn by this *Dial.*

The Hour of 12 can never come upon either the *East* or *West* Dial Planes, because at that Hour the Sun being upon the *Meridian*, the Shadow of the Style will be *parallel* to the Plane, and consequently can cast no Shadow upon it.

For the Hour Lines *and* Substylar Line.

How to draw the *Hour Lines.*

Then, having your Plane in readiness at about *one Third* of the depth of the Plane *from the Top*, draw the *Horizontal Line* A H, and make choice of a *convenient Point* therein, as at C, and draw the *Circle* P H D S, take 50 Deg. 44 Min. from your *Line of Chords*, (that being the Latitude of


An Erect Direct East Dial
4 5 6 7 8 9 10
P
Axis
C
H
Horizon
A
S Earths
D
Plate. 5.
Fig. 1.
Equinoctial
11
4
5
6
7
8
9 10 11
B
An Erect Direct West Dial
2 3 4 5 6 7 8
P
Earths
Horizon
H
C
Axis
A
Fig. 2.
D
S
7
6
5
1
Equinoctial
1 2 3 4
B

the City of *Exeter)* and set that distance *just now taken* from your *Line of Chords*, from H to P, draw P C S for the *Substylar Line*, and *Hour of Six*: [2] And at *right Angles* thereto, draw C D to represent the *Equinoctial*, and draw the *Line* B A to touch the *Circle* in S *parallel* to C D. [3] *Divide* the *Quadrant* D S into *six equal Parts*, and lay a Ruler to the *Center* at C and to *each Mark* in the *Quadrant* D S, and it will cut the *Line* B A in *the Points* where the *Hour Lines* are to pass: [4] Through *those* Marks in the *Line* B A draw Lines *parallel* to the *six a-clock Hour Line*, and they shall be the true *Hour Lines* upon the *Dial*. The Hours of 7 and 8 in the *Evening* are the *same distance* from 6, that 5 and 4 are on the *other side*.

An Example of a *direct West Dial* for *Exeter*.

For the Quarters *and* Half Hours.

The *Quarters* and *half Hours* are drawn in both these *East* and *West* Dials by *dividing* each *sixth Part* of the *Quadrant* D S into *four equal Parts*, and carrying them into the *Line* A B, by laying the Ruler to the *Center* C, and to *those* Parts in the *Arch* D S, as you were taught in drawing the *Hour Lines*.

How the *Quarters* and *Half Hours* are to be drawn.

For fixing the Style.

Fix the *Style* upon the *six a-clock Hour Line*, and at *right Angles* thereto, which

Of the *Style*.

CHAP. IX. may be a Plate of *Copper*, *Braſs* or *Iron* (as in Plates 5 and 6) whoſe *height* muſt be *equal to* C D, or the *three a-clock* Hour Line and then is your Dial finiſhed.

CHAP. IX.

To make a POLAR *Dial.*

Plate 6.

A Dial for the Iſland of St Thomas.

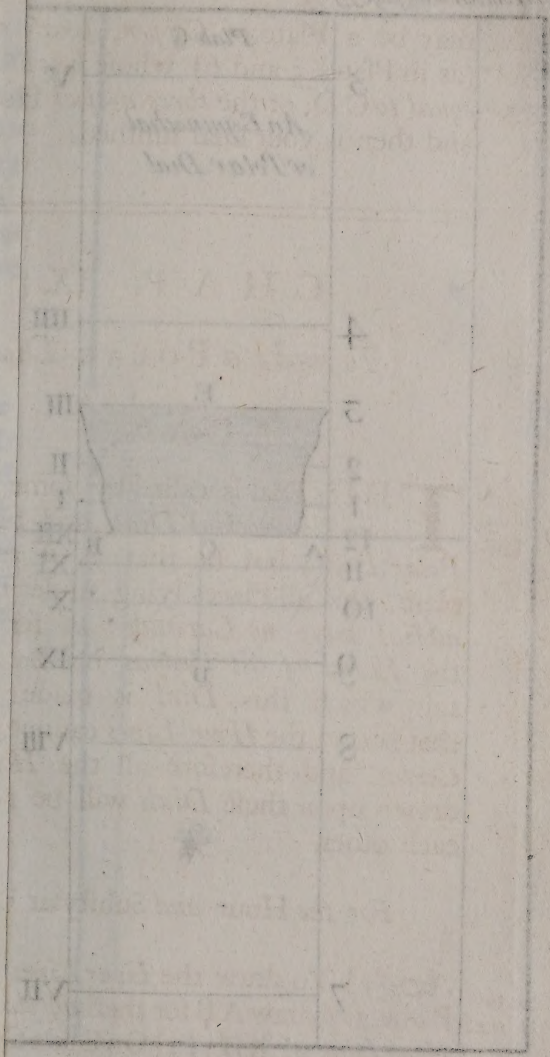
THIS Dial is called by ſome Author an *Equinoctial Dial*, and by others a *Polar Dial*; but be that as it will, it is plain, that all Places lying under the *Equinoctial* have *no Latitude:* as for inſtance the *Iſland of St Thomas* has *no Latitude* for which this *Dial* is made; and ſo that reaſon the *Hour Lines* cannot have any *Center*, and therefore all the *Hour Lines* drawn upon theſe *Dials* will be *parallel* to each other.

For the Hour *and* Subſtylar Lines.

How to draw the *Hour Lines.*

☞[1] To draw the *Hour Lines* upon this Plane, *firſt* draw A B for the *Subſtylar Line* and *Hour Line* of XII; [2] On C as a *Center* with the *Chord* of 60 *Deg.* draw the *Circle* A E B D, and draw the *two* Lines V VII, and

5·7



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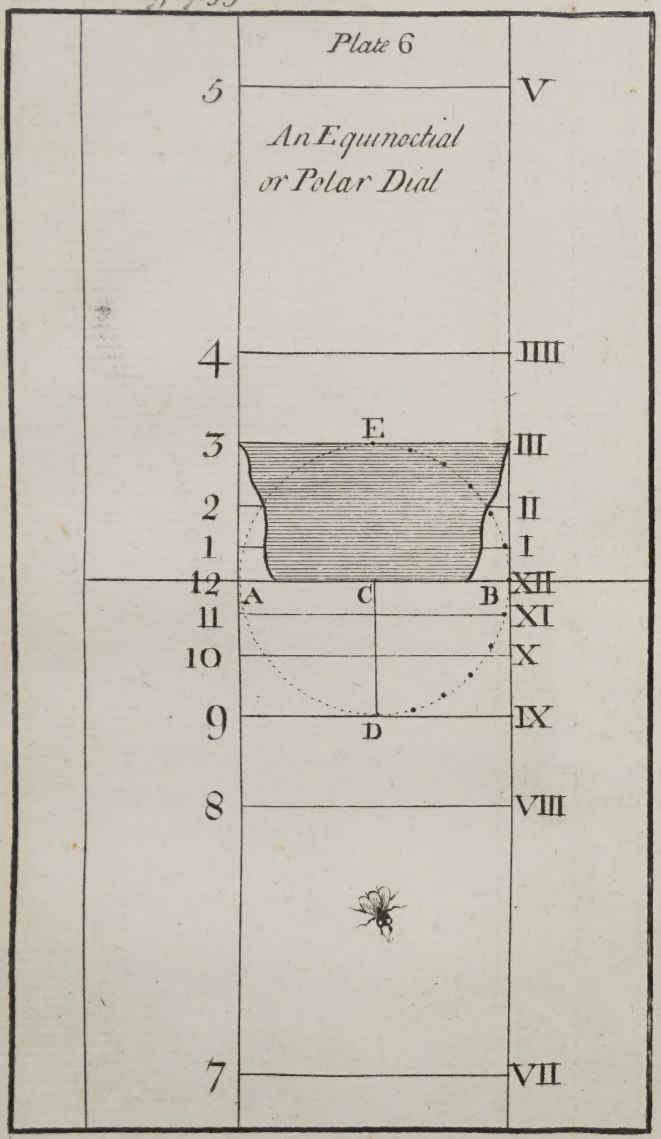

5. 7. *divide* the *Semicircle* E B D into 12 *equal Parts*, lay a Ruler to the *Center* of the *Circle* at C, and to *each* Mark in the *Circle*, and it will cut the *Line* V VII in the Points where the *Hour Lines* muſt paſs: [3] *Through* which Points draw Hour Lines *parallel* to A B, and they ſhall be the *true Hour Lines* that were required. CHAP. IX.

For the Style.

The *Stile* may be a broad Plate of *Copper*, *Braſs*, or *Iron*, at Pleaſure, placed at *right Angles* over the 12 *a-clock Hour Line*. Of the *Stile*.

The *Hour Line* of *ſix* never falls upon this Dial, becauſe *under the Equinoctial* the Sun *riſes* and *ſets* at *Six the Year throughout* with very little Variation.

CHAP. X.

CHAP. X.

To find the Declination * *of a* Wall *or* Plane *whereon to draw a* Sun-Dial.

Plate 7. Fig. 9.

A Description of the Instrument.

[1] PROCURE an oaken Board (which at *London* they call Wainscot) about a Foot square, more, or less, it matters not: Take A B C D about an inch thick, well plained on both Sides, and thereon paste a Sheet of good Paper very smooth, on which draw *two* or *three concentric* Circles, (it matters not how many, nor at what distance they be:) [2] In the *Center* I let there be an Hole to receive a *streight Wire* to screw up and down at pleasure, and to stand at *right Angles* to the Board itself; draw *two* Diameters and mark them with the Letters of the four *cardinal Points*, *East*, *West*, *North* and *South*: which *Line* N S represents the *Axis* of the *Wall*, *i. e.* it stands *perpendicular*, or at *right Angles*, to the *Wall itself*; and if it doth not decline from the *South* or *North*,

* See Page 24, Note 4.

nor

nor yet to the *East* or *West*, the said Line also represents the 12 *a-clock Hour-Line.* CHAP. X.

How to take the Declination.

[3]When you would take the *Declination* of a *Wall*, apply the *Edge* of the Instrument A B to the Wall; and in the *Forenoon*, the *Sun shining*, by help of your *Quadrant* place the Instrument parallel with the Horizon: screw up your *perpendicular Pin* in the *Center* till the *Shadow* of its *Top* touch *any of the Circles* (it matters not which) as suppose the *utmost* at F; let all Things now rest till *Afternoon*: [4] And then carefully observe where the *Top* of the *Shadow* toucheth the *same Circle* again, which we will suppose at G; thus is your observation finished: [5] Take your Instrument down, and with your Compasses *divide* the *Arch* F G into *two* equal Parts in H; and if from H you draw a Line through the *Center*, it shall be a *true* 12 *a-clock Hour Line*; and N H is the *Declination of the Wall*; which by applying it to the *Line of Chords*, I find to be 14 Deg. And when the Mark last found at H falls on the *East side* of the Line N S (as this doth) then is the *Declination* of the Wall *East*, but when the Mark falls on the *West side*, then the *Declination* is *West*.

CHAP. XI.

CHAP. XI.

To make an erect Declining DIAL.

An *erect declining* Dial what.

The *upright* or *erect* Dial Planes already treated of, are such as did *directly* face the *four cardinal* or principal Points of the *Horizon*, viz. *East*, *West*, *North*, and *South* Points. Now ALL OTHER *upright* or *erect* Dial Planes are said to *decline* *, and their *Declination* is counted from the *North* or *South*, towards *East* and *West*, and those Planes are called *South* or *North* erect Planes *declining East* or *West*.

Plate 7. Fig. 2.

Example of an erect Declining *Dial for* Liverpool, Warrington *or* Cronton *in* Lancashire.

LET it be required to make a Dial in the *Latitude* of 53 *Deg.* 22 *Min. North*, *declining* from the *South* to the *West*, 21 *Deg.* 10 *Min.*

First, *For the* distance *of the* Substylar Line *from the* 12 a-clock Hour Line.

How to find the *Style's distance* from the 12 *a-clock Line.*

[1] Draw the *Horizontal Line* A B, and from C let fall *perpendicular* the 12 *a-clock Hour Line* C D, and from the *Line of Chords*

* See Page 24. Note 4.

take

take 60 *Deg.* with your Compasses, and set one foot of the Compasses in C, and draw the *Semicircle* A D B: [2] And then draw C D at *right Angles* to A B for the 12 *a-clock Line*; [3] Take the *Complement of the Latitude* 36 *Deg.* 38 *Min.* from your *Line of Chords*, and set it from D to E, and draw E F *parallel* to A B, so is F E the *Sine* † of the *Arch* D E. This done, CHAP. XI.

[4] Take in your Compasses the *Plane's Declination* 21 *Deg.* 10 *Min.* from your *Line of Chords*, and set it from D to G, and draw C G. [5] Take E F in your Compasses, and set it from C to H, draw H I *parallel* to A B; [6] Take H I, and set from F to L, and draw C L M, now D M measured on your *Line of Chords* is 15 *Deg.* 2 *Min.* the *Substylar Lines* distance from the 12 *a-clock Line.*

Secondly, *For the* Styles height.

[1] From the Point H, draw the Line H K *parallel* to C D the 12 *a-clock Line*; [2] Then take H K in your Compasses, and set it from L to N, and draw C N for the *Top of the Style*; [3] Then shall M N measured on your *Line of Chords* be 31 *Deg.* 49 *Min.* the *height* of the *Style.* Of the *height* of the *Style.*

† The *Sine* of an *Arch* is a Line drawn from *any Point* of the *Circumference of a Circle* to that Line that passes thro' the *Center* of the said *Circle.*

CHAP. XI.

Thirdly, *For the* difference of Inclination * of Meridians.

Of the difference of *Inclination of Meridians.*

[1] Set one Foot of your Compasses in M, and take the *neareſt diſtance* to E F. *This diſtance* ſet upon the 12 *a-clock Line* from F to O. [2] Then take the *diſtance* from O to G, and ſet it from O to P, [3] Take the *diſtance* P M in your Compaſſes, and meaſure it on your *Line of Chords*, and you will find it to be 25 *Deg.* 46 *Min.* the *Inclination of Meridians* ſought: This 25 *Deg.* 46 *Min.* reduced into Time (by the *Table* III.) is 1 *Hour*, 43 *Min.* 4 *Seconds*, by which I ſee that the *Subſtylar Line* will fall *between* the *Hours* of *one* and *two* a-clock in the *Afternoon.*

Laſtly, *For the* Hour Lines.

Of the *Hour Lines.*

[1] In any *convenient* Place *in the Subſtylar Line* (according to the Largeneſs of your Dial Plane) as at M, draw the Line R S at *right Angles* to the *Subſtylar Line* C M, [2] Set one foot of your Compaſſes in M, and take the *neareſt diſtance* to C N *the Style's heigbt*, [3] One foot reſting in M, turn the other to

* See *Plate* 7. *Fig.* 1. in which H I repreſents the 12 *a-clock Hour Line* in that Place, and N S is the Line that is *perpendicular* to the *Plane*; now the *Angle* that is made between theſe two Lines at I, is what in Dialling is called the *Inclination of Meridian.*

q in

q in the *Subſtylar Line* upon q as a *Center*, with the *diſtance* q M draw *the Circle* as you ſee done in the Dial, which doth repreſent the *Equinoctial.* CHAP. XI.

[4] Lay a Ruler from *its Center* at q to D (that is the Place where the *Line* R S cuts the 12 *a-clock Hour Line)* and then the Ruler doth cut the *Equinoctial* in a Point *near* O where you are to begin to divide it into 24 *equal Parts*, which I have here marked with little *Dots.* [5] Lay a Ruler to the *Center* at q, and to *every one* of the *equal Diviſion* in the *Equinoctial*, and where the Ruler cuts the *Line* R S, make theſe marks * * * *Laſtly*, draw Lines from the *Center* of the Dial at C to theſe marks * * * in the *Line* R S, and thoſe are the true *Hour Lines* upon the Dial, as was required; to which place the proper Figures to *every Hour*, as you ſee done in the *Scheme.*

Of the hanging *of the* Style.

The *Style* C N muſt hang *directly Square-wiſe* with the *Subſtylar Line* C L, and this you muſt try with your *Quadrant*, thus; place *that edge* of your *Quadrant* upon which *the Sights are*, to the *Top of the Style*, and when the *Thread* cuts the *Limb* of the *Quadrant* in the *ſame Degree* with the *Latitude of the Place*, then it is *right*, otherwiſe it is *wrong.* How the *Style* muſt hang.

Note,

CHAP. XI.

Note, *Now you have finiſhed your Dial, and in ſo doing, you have in the making of this* one *made* four *Dials*, viz.

	Deg.	*Min.*
A South Declining Eaſt A South Declining Weſt A North Declining Eaſt A North Declining Weſt	21	10

The *name of the Hours* and *Place of the Style* muſt be changed.

But you muſt change the *Names* of the *Hours*, viz. 10 into 2, 9 into 3, 8 into 4, *&c* †. and place the *Style* on the *contrary Side* of the 12 *a-clock Line* for the *South* declining *Eaſt*, and by turning the Dial *upſide downwards*, for the *North Decliners*, ſo that the *Style* may point *upwards* to the *North Pole*, and the Hours about midnight omitted, as your own Reaſon will ſoon direct you.

† And here you are to obſerve that it is *not the Style* that changes its *Place* or *Poſition*, but the *Plane itſelf*; for the *Style* anſwering to the *Latitude of the Place*, it remains *always ſteady* and the ſame in *all Declinations:* ſo that if you conceive a Plane *declining* (as in the *Example* now before us) 21 *Deg.* and 10 *Min.* to the *Weſtward*, the *Subſtylar Line* falls betwixt the Hours of *One* and *Two* in the Afternoon; and ſuppoſing the *ſame Plane* to move to the *Eaſtward* 21 *Deg.* 10 *Min.* the *Subſtylar Line* will then fall betwixt the Hours of *Ten* and *Eleven* in the Morning. For it is *an infallible Rule*, that if the Plane *declines Eaſtward*, the *Subſtylar Line* falls amongſt the *Morning Hours*, but if *Weſtward* amongſt the *Afternoon Hours.*

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Plate 7

The Instrument for finding the Declination of a Wall &c

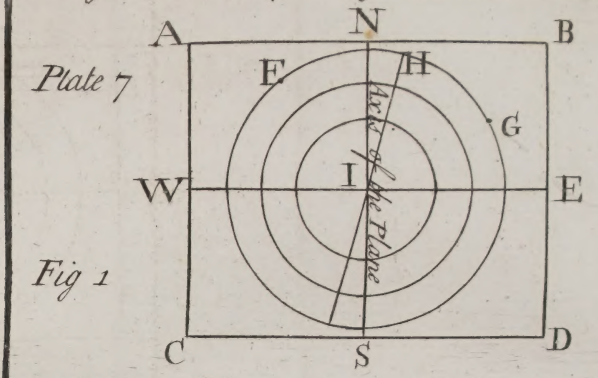
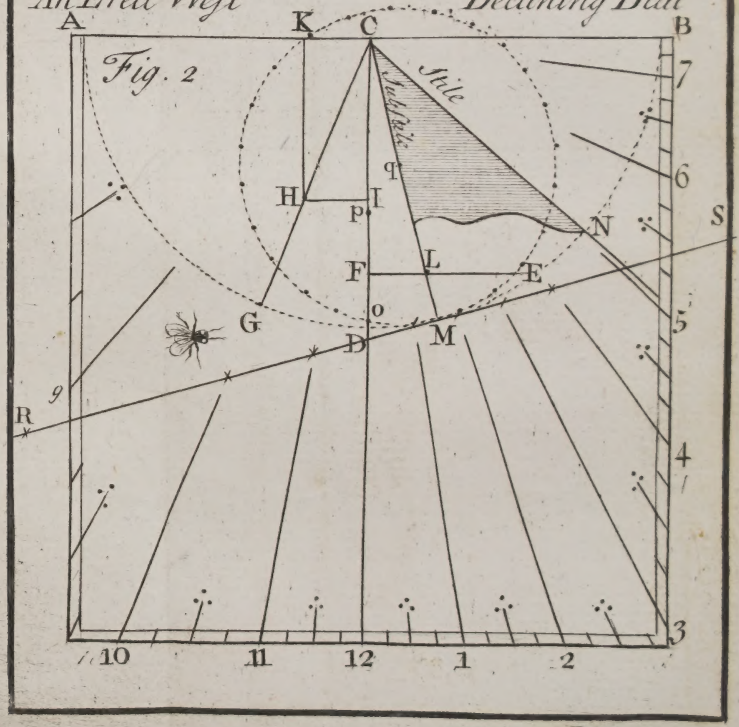


Fig 1

An Erect West Declining Dial



CHAP. XI.

☞ Here you are to take notice, that if the Plane *decline* 60 *Deg. or more*, then the *Hour Lines* having *Centers* will be so near together, and the *Style* will then be so near the *Plane*, that *one* thing will much discommode *another*, and make it a great difficulty to shew the *true Hour* of the Day thereby; therefore they ought to be removed *far* from the *Center* that they may become *wide enough* to answer the end of shewing distinctly the true Hour of the Day.

How to proceed if *the Plane* declines 60 *Deg.* or more.

But still here will arise a Difficulty in *dividing the Circle*, which represents the *Equinoctial*, for there will be required the Difference of the *Inclination of Meridians* of the Plane and Place, for this Purpose I have added *Table* V. for the *Latitude* of *London*, shewing the *Style's height*, *Substyle's distance* from the *Meridian*, and difference of *Inclination of Meridians*, which tho' calculated indeed for the *Latitude* of *London*, (*viz.* 51 *Deg.* 32 *Min.*) yet may serve indifferently for most Places in *England*; but he that wants to be more curious and exact, may, by observing the Directions given in the beginning of this Chapter for finding the *three Requisites*, (by that means) obtain *those Requisites* for any Place in the known World.

A *Table* at the end of the Book for avoiding the Difficulty of *dividing the Equinoctial*.

CHAP.

CHAP. XII.

CHAP. XII.

To make a Dial upon a Plane when the Pole *has but a* ſmall Elevation *above the Plane.*

Plate 8. Fig. 1.

I Shall take for *an Example* a Dial that I made at *London*, whoſe Plane *declined* from the *South* by the *Eaſt*, *northerly* 100 *Deg.* 16 *Min.* that is 79 *Deg.* 44 *Min.* from the *North* towards the *Eaſt*.

For the Style's height.

Of the *height* of the *Style.*

☞ The *Style's height* you will find by *Conſtruction*, as in Chap. X. or by *Table* V. to be 6 *Deg.* 22 *Min.* the *Subſtyle's diſtance* from the *Meridian*, 38 *Deg.* 1 *Min.* the *Inclination of Meridians*, 81 *Deg.* 56 *Min.*

[1] Let the *Square* A B C D repreſent the Plane, becauſe 'tis a *North* Plane *declining Eaſtward*, therefore the *Style* muſt point *upwards*, and the *Center* of the *Hour Lines* will be *ſome where below* the Plane itſelf. And therefore take 60 *Degrees* from your *Line of Chords*. Set one Foot of your Compaſſes at the *bottom Corner* of the Plane at C, and draw the *Quadrant* E F. [2] Take 38 *Deg.* 1 *Min.*

1 *Min.* from your *Line of Chords*, (the *Sub-ſtyle's* diſtance from the 12 *a-clock Line)* and ſet it from F to G, then draw C G *continued* for the *Subſtylar Line.* [3] Take 6 *Deg.* 22 *Min.* the *Style's height* from your *Line of Chords*, and ſet it from G to H, and draw C H for the *Style:* [4] Now, becauſe the *Style* has but *ſmall height*, draw an *other Line* I K *parallel* to the *Style* of the *Dial*, at ſuch *convenient* diſtance as in your judgment will beſt fit the Dial Plane, *viz.* that all the *Hour Lines* may fall thereon, ſo ſhall that Line I K be the *enlarged Style* of the Dial. CHAP. XII.

For the Hour Lines.

[5] Now by the *Subſtylar Line*, and this *enlarged Style*, the *Hour Lines* may be drawn (at *convenient* diſtances) without any regard had to the *Center* of the Dial. How the *Hour Lines* may be drawn.

And to do that, aſſume any *two Points* in the *Subſtylar Line* C G, at ſome *convenient* diſtance from each other, as L and M, and through thoſe *two Points* draw *two ſtreight Lines*, both of them at *right Angles* to the *Subſtylar Line* C G, as the Lines N L O and P M Q, [6] Set one foot of the Compaſſes in L, and take the *neareſt* diſtance to the *enlarged Style* I K, and turn that foot from the *Style* to R; on R as a *Center* with the diſtance L R draw a *Semicircle*, ſet one foot of the Compaſſes in M, and take the

CHAP. XII.

nearest distance to the *enlarged Style* I K, and turn *that foot* from the *Style* to S; on S, as a *Center*, draw a *Semicircle.*

[7] Take the Plane's *Inclination of Meridians*, 81 *Deg.* 56 *Min.* and set from L to T, and from M to V upon the *Semicircles.* Then

[8] Divide *each Semicircle* into 12 *equal Parts*, beginning at T and V; lay a Ruler to the *Centers* R and S *severally*, and to the *Marks* just now made in the *Semicircles*, and the Ruler will then cut the *Lines* P M Q and N L O in the true Places where the *Hour Lines* must be drawn.

Lastly, Lay a Ruler to *those Marks* in the *Lines* P M Q and N L O, and draw *right Lines* through the *Plane*, and they shall be the *true Hour Lines* required, and will be removed far enough from the *Center*, and that will shew distinctly the Hour of the Day.

For the Style.

The *Style* to stand at *right Angles.*

The *Style* must stand at *right Angles* upon the *Substylar Line* I K.

For the Quarters.

The Quarters of Hours *how drawn.*

The *Quarters* are drawn by dividing *each* of the 12 *equal Parts* in the *Semicircles* into *four equal Parts more*, and from *those* Divisions

An Erect great Decliner

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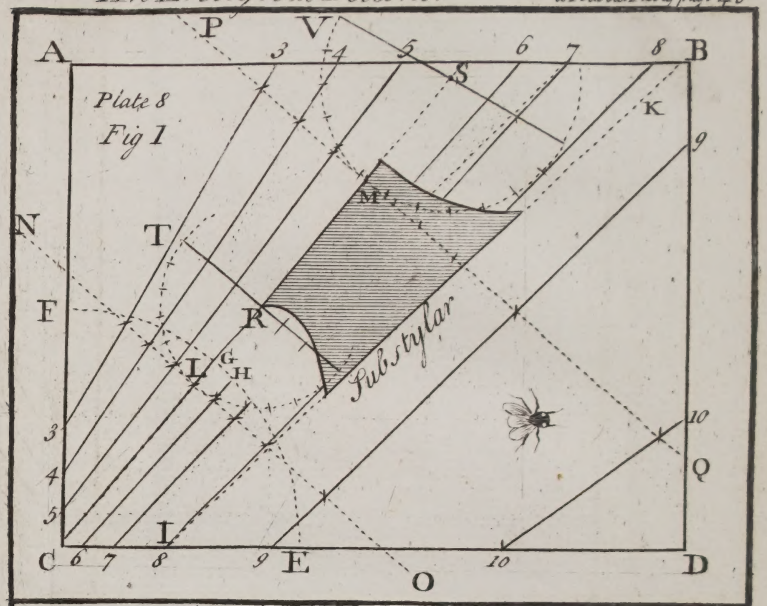
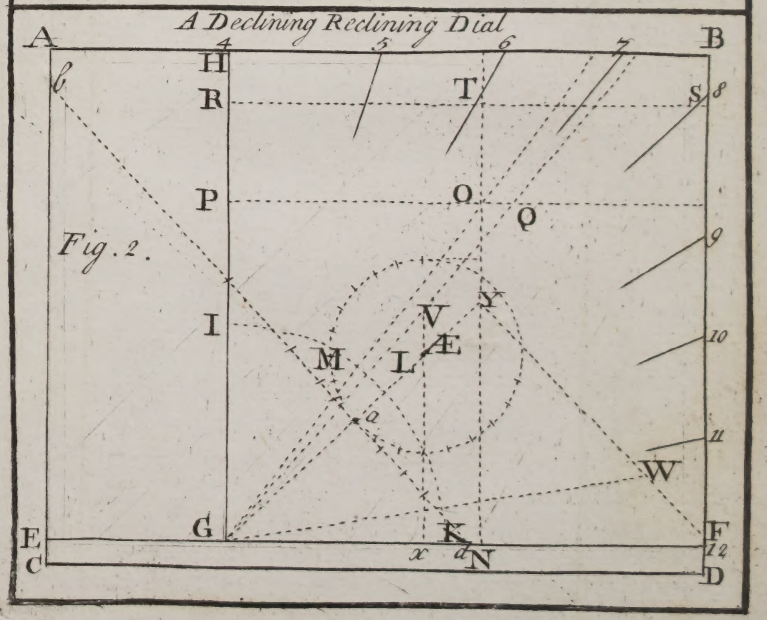




visions draw Lines, as has been taught above for drawing the *Hour Lines*, and your Dial is finished. CHAP. XIII.

CHAP. XIII.

To make a declining reclining * DIAL.

Plate 8. Fig. 2.

SUCH Planes as do directly face the *South* or *North Points* of the *Horizon*, but do *recline* (or fall backwards) from the *Zenith* (like the Roof of a House) towards the *South* or *North* are called *South* or *North Direct* Planes *reclining* so many *Degrees* as the *Reclination* is; and the Number of *Degrees* that the Plane *reclines*, may be found by applying the *edge* of your *Quadrant*, in which the *Sights* are placed to the *Plane*, and the *Thread* will cut the *Limb* in the *Number of Degrees* that the Plane *reclines*, which being a Thing so plain, I need not give any Example. Of *South* and *North* reclining Planes.

And of *reclining Planes* there are *Six* Varieties, *three* of *South*, and *three* of *North* *Six* different Sorts of *reclining* Planes, *viz.* 3 *North* and 3 *South*.

* Those *Dial Planes* that *lean from you* when you stand *before them*, are called *reclining Planes*, because they *recline* from the *Zenith*.

Recliners,

CHAP. XIII.

Recliners, all which may be reduced to *new Latitudes*, wherein they will become *Horizontal Planes*, and consequently Dials may be made as has been taught, Chap. IV. where I have shewn how to draw *Hour Lines* upon an *Horizontal Plane*.

First of Direct SOUTH Recliners.

The 1st *Variety* instanced in a *South reclining* Dial for *Cambridge*.

First Variety: Let there be a *direct South Plane* in the *Latitude* of *Cambridge*, which is 52 *Deg.* 17 *Min.* which *reclines* from the *Zenith* thereof 26 *Degrees*; in what *Latitude* will that be an *Horizontal Plane?*

Now, because the *Reclination* is *less* than *the Complement of the Latitude* 37 *Deg.* 43 *Min. Substract* the Planes *Reclination* 26 *Deg.* from the *Complement of the Latitude* 37 *Deg.* 43 *Min.* and the *Remainder* 11 *Deg.* 43 *Min.* is the *new Latitude* in which it becomes an *Horizontal Plane*.

The Operation.

	Deg.	*Min.*
The *Complement* of the Latitude at *Cambridge* is — —	37	43
The Plane's *Reclination* there (which *substract)* is ——	26	00
The *new* Latitude is ——	11	43

So

So that an *Horizontal Dial* made for the *Latitude* of 11 *Deg.* 43 *Min.* ſhall be a *South Recliner* 26 *Degrees* in the *Latitude* of *Cambridge.* CHAP. XIII.

Second Variety. If the *Reclination* of the Plane be *equal* to the *Complement of the Latitude of the Place*, the *new Latitude* is *nothing*, that is, neither *Pole* has any *Elevation* above ſuch a *Plane*, and the *Hour Lines* are all *parallel*, and the *Style* is likewiſe *parallel* to the *Plane itſelf*; and therefore, a Dial for ſuch a Plane muſt be made in *all reſpects*, as has been ſhewn *Chap.* IX. *Plate* 6. 2d *Variety.*

So that admit at *Lincoln*, where the *Latitude* is 53 *Deg.* 15 *Min.* a *South* Plane *reclines* from the *Zenith* 36 *Deg.* 45 *Min.* (which is equal to the *Complement of the Latitude* of that City) I ſay, it becomes an *Horizontal Dial* under the *Equinoctial*, as appears by the Operation. Inſtanced in a *South reclining* Dial for *Lincoln.*

The Operation.

	Deg.	*Min.*
The *Complement* of the Latitude at *Lincoln* is —— ——	36	45
The Plane's *Reclination* there (which *ſubſtract*) is ——	36	45
So you ſee the *new* Latitude is —	00	00

CHAP. XIII.

In *Plate* 6. you have the Dial that is for this Purpose.

3d *Variety.*

Third Variety. If the *Reclination* of the Plane *exceeds* the *Complement of the Latitude of the Place*, then *subtract* the *Complement of the Latitude* from the *Plane's Reclination*, and the *Remainder* is the *new Latitude*, where it will become an *Horizontal Plane.*

Example.

Instanced in a *South reclining* Dial for *Norwich.*

Suppose at *Norwich*, whose Latitude is 52 *Deg.* 43 *Min.* a *direct South* Plane *reclining* 56 *Deg.* from the *Zenith*, where will that be an *Horizontal Dial?*

The Operation.

	Deg.	*Min.*
The Plane's *Reclination* ——	56	00
Complement of the Latitude of *Norwich* (which *subtract*) —	37	17
The *New* Latitude is ——	18	43

So that an *Horizontal Dial* made for the *Latitude* of 18 *Deg.* 43 *Min.* will be a *direct South reclining Dial* from the *Zenith* of *Norwich* 56 *Degrees.*

Secondly,

CHAP. XIII.

Secondly, *Of direct* NORTH Recliners.

First Variety. If the *Reclination* be less than the *Complement of the Latitude of the Place, add* them together, and that is the *new Latitude* where *such Recliner* will become an *Horizontal Plane.* 1st *Variety.*

Example.

Suppose at *Newcastle upon Tyne,* whose Latitude is 54 *Deg.* 57 *Min.* a *direct North* Plane should *recline* from the *Zenith* 29 *Deg.* how must the *Hour Lines* be drawn thereon? Instanced in a *North reclining* Dial for *Newcastle upon Tyne.*

To the *Complement of the Latitude* of *Newcastle upon Tyne,* 35 *Deg.* 3 *Min. add* the *Plane's Reclination* 29 *Deg.* and their *Sum* is 64 *Deg.* 3 *Min.* and that is the *new Latitude,* for which Place make an *Horizontal Dial,* as has been before taught, and that will be a *North reclining Dial* at the Place above-mentioned.

The Operation.

	Deg.	*Min.*
The *Complement* of the Latitude at *Newcastle upon Tyne* is —	35	03
The Plane's *Reclination* there (which *add*) is — —	29	00
The *new* Latitude — — —	64	03

CHAP. XIII.

2d *Variety.* *Second Variety.* If the *direct North* Plane *recline equal* to the *Latitude of the Place*, *add* it to the *Complement of the Latitude*, and *that Sum* will always be 90 *Deg.* so that *under the Pole* it becomes an *Horizontal Dial*; make a Dial as has been taught in *Chap.* III. *Plate* 3. *Fig.* 1. by dividing a Circle into 24 *equal Parts*, and fixing a Wire *perpendicular* in the *Center*, and it is done.

Example.

Instanced in a *North reclining* Dial for *Wrexham.* Suppose at *Wrexham* in *Denbighshire*, whose Latitude is 53 *Deg.* 6 *Min.* a *direct North* Plane reclines 53 *Deg.* 6 *Min.* I desire to know *where* this will become an *Horizontal Plane?*

The Operation.

	Deg.	*Min.*
The *Complement* of the Latitude at *Wrexham* is — —	36	54
The Plane's *Reclination* there (which *add)* is — —	53	06
The *new* Latitude is — —	90	00

3d *Variety.* *Lastly.* If the Plane's *Reclination* exceed the *Complement of the Latitude of the Place*, *add* them together, and *that Sum* is the

new Latitude where *such a Plane* will become an *Horizontal Plane.* CHAP. XIII.

But note, if the Sum *exceed* 90 *Deg.* take the *Complement* thereof to a *Semicircle*, or 180 *Deg.* and the *Remainder* is the *new Latitude*, where such a *Reclining* Plane will become *Horizontal.*

Example.

Instanced in a North Reclining *Dial for* Shrewsbury.

Suppose at *Shrewsbury*, whose *Latitude* is 52 *Deg.* 44 *Min.* a *direct North* Plane *reclines* from the *Zenith* 60 *Deg.* where will it become an *Horizontal Plane?*

To the *Complement of the Latitude of the Place* 37 *Deg.* 16 *Min. add* the Plane's *Reclination* 60 *Deg.* and *their Sum* is 97 *Deg.* 16 *Min.* whose *Complement* to 180 *Deg.* is 82 *Deg.* 44 *Min. in which Latitude* such a Plane at *Shrewsbury* will become *Horizontal*; therefore draw *Hour Lines* thereon, as you have been taught in making the *Horizontal Dial*, and they will be the true *Hour Lines* for that Plane and Place, as just now mentioned.

The Operation.

	Deg.	*Min.*
The *Complement* of Latitude at *Shrewsbury* is — —	37	16
The Plane's *Reclination* there (which *add)* is ——	60	00
The Sum (which is to be *subtracted* from the *Semicircle*) —	97	16
A *Semicircle* is (180 *Degrees*) —	180	00
The Sum as above to be *subtracted* —— ——	97	16
The *new* Latitude —— —	83	44

Note, That in making of any of these *North* or *South reclining Dials*, you have also made (at the same Time) a *direct North* or *South inclining Dial* from the *Zenith*, 26 *Deg.*

As in the *first Variety* for *Cambridge*, you have made also a *North Dial inclining* to the *Horizon* 26 *Deg. either* by drawing of the *Hour Lines* and *Style through the Center*, or by turning the *reclining Dial* about, *upon* the *Hour Line of Six*; and then as the *North Pole* is raised or elevated upon the *South Recliner*, so much will the *South Pole* be raised or elevated above the *North Incliner*.

CHAP.

CHAP. XIV.

To make an East *or* West RECLINING * *Dial.*

AS all *North* and *South reclining* Dial-Planes, were reduced to *new Latitudes*, wherein they would become *Horizontal Planes*; and thereby made by the Directions given in *Chap.* IV. so all DIRECT *East* or *West Reclining* Dial Planes in *any Latitude*, may be reduced to *erect* or *upright* DECLINING *Planes* in *another Latitude*, and therefore may be made by the Directions in *Chap.* XI. of this Treatise; yet I shall here shew, for the young *Tyro's* Improvement, how they may be done *mechanically*, without any such Alteration. But first, to reduce them to new Latitudes.

All direct *East and West* Recliners *are reducible to* erect Decliners *in other Latitudes.*

* As in *upright* or *erect* Dial Planes there were two Sorts or *Varieties*, *viz. Erect direct* and *erect Declining*; so there are two Sorts or *Varieties* of *Reclining* Dial Planes likewise: For such *Reclining* Planes as do *directly* face either the true *East*, *West*, *North*, or *South* Points of the Heavens are called DIRECT *Reclining* Planes.

Again, those *Reclining* Planes which do not *directly* face the said *Cardinal Points*, but deviate therefrom, *i. e.* face some other Points situate between them, as *South-East*, *North-West*, *North-East*, *&c.* are called DECLINING *Reclining* Planes, and the manner of drawing the *Hour Lines* upon these *Direct* and *Declining Reclining* Planes, affords a much greater Variety than there was in the *erect* or *upright* Planes. See Page 24.

CHAP. XIV.

The Rule.

The *Complement* of the *known Latitude* or *Latitude you are in*, is always the *new Latitude*, and the *Complement* of the *Reclination* * is always the *Declination* in that *new Latitude*, in which it will become an *erect declining* Plane.

And before I proceed any further, it is proper to inform you how you shall know whether the *North* or *South Pole* is *elevated* above any given Plane.

Of the Elevation *of the* Pole *in* Horizontal *Dials*.

[1] All *Horizontal Planes* in *North Latitude* have the *North Pole* elevated; but all Horizontal Planes in the *South Latitude* have the *South Pole* elevated.

Of the Elevation *of the* Pole *in* erect *direct or* declining *Dials*.

[2] Upon all *erect Planes* whether *direct* or *declining*, if it face the *South*, the *South Pole* is elevated; but if it face the *North*, the *North Pole is elevated*, as you may the better perceive by viewing the *erect direct North* and *South* Dials in *Plate* 11.

Of the Elevation *of the* Pole *in* direct *East and West* Recliners *and* Incliners.

[3] Upon all *direct East* and *West* Planes (let them recline ever so far) the *North Pole* is elevated; but on their *opposite Incliners* the *South Pole*.

* The *Reclination* of a Plane is the Quantity of *Degrees* which any Plane, on which a Dial is supposed to be drawn, *lies or falls* back from the *truly erect* or *upright* Plane.

[4] Over

CHAP. XIV.

[4] Over all *North reclining Planes*, whether *direct* or *declining* the *North Pole* is elevated, and over the *oppoſite Incliners* the *South Pole*.

Of the Elevation *of the* Pole *in* North *Recliners and Incliners.*

Laſtly. Over all *South reclining direct* or *declining*, if the *Plane paſs between* the *Zenith* and the *Pole*, the *South Pole* is elevated, as in the *North Pole* on their *oppoſite Incliners*, and *if the Plane lie between the Pole and the Horizon*, the *North Pole is elevated*; but the *South* over their *oppoſite Incliners*.

Of the Elevation *of the* Pole *in* South *Recliners and Incliners.*

Now let it be required to make an *Eaſt Dial* for *Worceſter*, to *recline* 40 *Degrees*; According to the *former* Method of reducing it to *new Latitudes*, it will be an *erect Dial* in *Latitude* 37 *Deg.* 46 *Min.* (that being the *Complement of the Latitude* of *Worceſter*) *declining* from the *South Eaſtward* 50 *Degrees*, that being the ☞ *Complement of the Plane's Reclination.* So that if by the Directions in the XIth *Chapter*, you make an *erect Dial* for 37 *Deg.* 46 *Min. North* Latitude, *declining* 50 *Deg. South Eaſt*, it will be an *Eaſt Recliner* 40 *Deg.* from the *Zenith*, in the *Latitude* of 52 *Deg.* 14 *Min.* However I ſhall here ſhew how to do it *mechanically*.

Example of an Eaſt reclining Dial *for* Worceſter.

Firſt. You muſt conſider, that the *Eaſt* and *Weſt* RECLINERS have their *Center near* the *Bottom* of the *Plane*, but the INCLINERS of both ſorts have their *Centers*

CHAP. XIV.

Centers near the *Top:* And the *Eaſt* INCLINER and *Weſt* RECLINER muſt have their *Centers towards* the *right Hand*; but the *Eaſt* RECLINER and *Weſt* INCLINER have their *Centers towards* the *left Hand.*

Theſe things being *well underſtood*, I ſhall now proceed to practice.

Having made choice of your *Plane*, as ſuppoſe A B C D. *Plate* 8. *Fig.* 2.

For the Subſtylar Line *and* Style's height.

According to the foregoing Directions, I obſerve that the *Center* of *this* Dial muſt be at the *Bottom* towards the *left Hand:* therefore [1] at the *Bottom* of the *Plane*, draw the *Line* E F for the 12 *a-clock Line*, in which make choice of ſome *convenient* Place, as at G; [2] chuſe G for the *Center* of the *Dial*, and from G draw G H at *right Angles* to E F. [3] Then with one foot of the Compaſſes in G, deſcribe the *Quadrant* I K, and by the help of your *Line of Chords*, ſet off the *Plane's Reclination* 40 *Deg.* from I to L, and draw the *Line* G L *as long as you can.* [4] *Alſo* ſet off from I to M the *Complement of the Latitude of the Place* 37 *Deg.* 46 *Min.* and draw the *Line* G M *as long as you can*; [5] then in *any* Point at Pleaſure in the 12 *a-clock Line* E F, chuſe a *Point*

a *Point* as N, and from that *Point* draw a Line *parallel* to G H, as N O; and through the Point where it *cuts* the *Line* G M, draw P O *parallel* to E F; [6] take G Q in your Compaſſes, and ſet it from G to R, and draw R S *parallel* to *the Meridian* E F, and it will cut N O, in T; [7] ſet *the Diſtance* P Q from G to V, and draw V X *parallel* to T N; [8] take in your Compaſſes G X, and ſet it from T to Y, and draw G Y for the *Subſtyle*; [9] from Y *erect the perpendicular* Y W, take V X in your Compaſſes, and ſet it from Y to W, and draw G W for the *Style:* The *Triangle* G Y W, repreſenting the *Style* of your Dial, which being erected *perpendicular* to the *Plane*, upon the *Subſtyle* G Y, ſhall give the *Hour* by the Shadow of its *upper* edge. CHAP. XIV.

For the Hour Lines.

[1] Chuſe a *Point* at Pleaſure in the *Subſtyle* G Y, as at *a*; through *that*, at *right Angles* thereto, draw the *Line b a*, *as long as you can*; ſet one foot of the Compaſſes in *a*, *viz.* the *Point* where the *Line b a* cuts the *Subſtyle*, and take the *neareſt diſtance* to the *Style's height*; let *one* foot reſt in *a*, and turn the *other* to Æ in the *Subſtyle*, and on Æ as a *Center* deſcribe the *Semicircle* (or a whole *Circle* if you pleaſe). [2] Lay a Ruler to the *Center* of the *Circle* at Æ, and to *d*, that

CHAP. XIV.

that is, where the *Line b a* cuts the 12 *a-clock Line* G F, and where the Ruler cuts the *Circle*, there you are to begin to divide it into 24 *equal* Parts: a Ruler laid to Æ, and to the *equal Parts* in the *Circle*, will cut the *Line b a* into *unequal Parts*, *where* make *Marks* * * * *Lastly.* A Ruler laid to the *Center* of the Dial at G, and to *those Marks* * * * in the *Line b a* will be the true *Hour Lines* required.

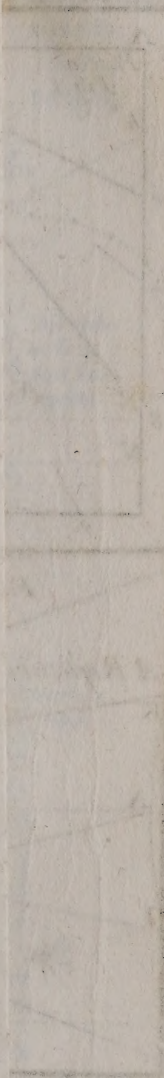
The *Line* G F being the 12 *a-clock Line*, you must place 12 at the *end*, as you see in the *Figure*, and the rest 11. 10. 9. 8. 7. 6. and then your Dial is finished.

N. B. In drawing *this* Dial, you have made *three more*; for if it is *turned upside down*, then it is a *West* Dial *inclining* 40 *Degrees*, with *this Alteration only*, that where 11 *now* stands you must place 1, and 2 where 10 is, *&c.* and *consequently* the *Sub-style* will *then* be as much on the *right Hand*, as it is *now* on the *left*.

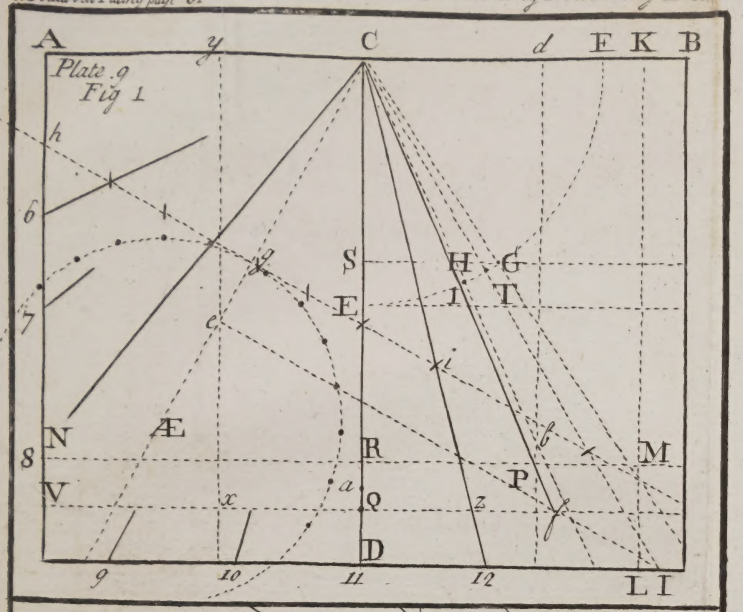
If it were drawn upon *oyled Paper*, the *back-side* would be a *West* Dial, *reclining* 40 *Deg. only* the Figures 12. 10. 9. *&c.* must be 1. 2. 3. *&c.*

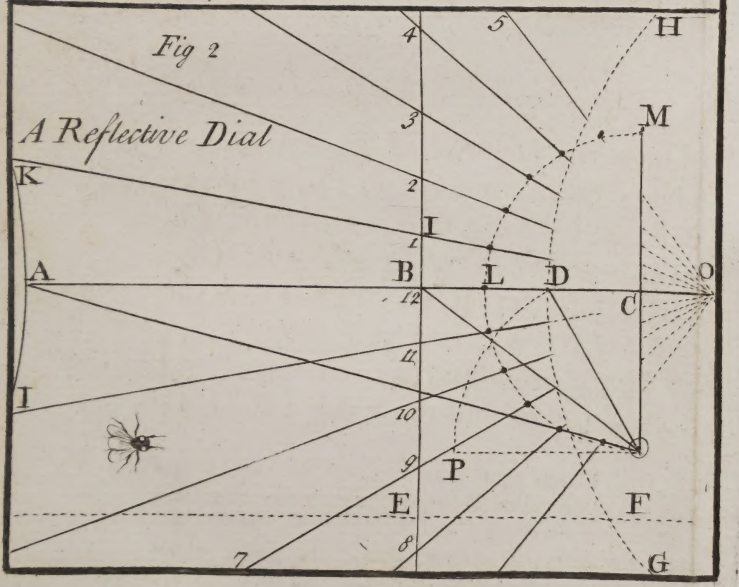
Lastly, If the 12 *a-clock Line* G F be *turned upwards*, the *back-side* will be an *East* Dial *inclining* 40 *Deg.* and the Figures must remain just as they are; *only* the *Sub-style* must be *as far* to the *left Hand* of the *Perpendicular* G H, as it is *now* on the *right*.

CHAP.



to Fould out Facing page 61 A North or South Declining Inclining Dial





CHAP. XV.

CHAP. XV.

To make a North or South Declining * Reclining or Inclining Dial.

Plate 9. Fig. 1.

THESE *Dial Planes* cannot be reduced to *new Latitudes* without the help of *Trigonometry*, therefore I shall proceed *Mechanically*. *Not reducible to new Latitudes.*

Take for an *Example* a Plane at *Edinburgh*, *declining* from the *South* to the *East* 30 *Deg.* and *reclining* from the *Zenith* 25 *Deg.*

First for the Style.

[1] Draw the *Horizontal Line* A B; [2] make choice of any *convenient* Place in the Line A B, as C, for a *Center*, and draw C D. [3] With your *Line of Chords* of 60 *Deg.* draw the *Quadrant* E F. [4] Take the *Complement of the Latitude of Edinburgh* 33 *Deg.* 53 *Min.* from your *Line of Chords*, and set it from E to G, and draw the Line C G *How the* Style *is found.*

* Those Dial Planes that *lean towards you* when you stand *before them* are called *Inclining*, and those that *lean from you* are called *Reclining*; and *Declining*, *Reclining* or *Inclining* Dials, are those whose Planes *neither* face *directly* any of the *four Cardinal Points*; nor are they either *perpendicular* or *parallel* to the *Horizon*.

as

CHAP. XV.

as long as you can. [5] Take the Plane's *Declination* 30 *Deg.* from your *Line of Chords*, and set it from E to H, and draw the Line C H, *as long as you can.* [6] Take the *Inclination of the Plane* 25 *Deg.* from your *Line of Chords*, and set it from E to I, and draw the Line C I *as long as you can.* [7] Make choice of a Point in the Line A B as K, and draw K L *parallel* to C D, and it cuts the *Line* C G *(the Complement of the Latitude)* in M, and thro' that *crossing* draw M N *parallel* to A B, and it *cuts* the *Line of Inclination* C I in P. [8] Take C P, and set it from C to Q, draw Q V *parallel* to A B: [9] Take R P in your Compasses, and set it from C to S, and draw S H *parallel* to A B, to cut the *Line of Declination* C H in H: [10] Take C K in your Compasses, and set it upon the *Line of Declination* from C to T, and draw E T *parallel* to A B: [11] Take E T in your Compasses, and set it from Q to X, and draw X Y *parallel* to C D. [12] Now take in your Compasses the *distance* S H (that is from C D to the *Line of Declination)* and set it from Q to Z, and draw C Z for the *Meridian Line*, or *Hour Line* of 12. [13] Take in your Compasses the *distance* C S, place *one* Foot in E, and make a Mark where the *other* Foot falls at *a.* [14] Take C *a*, and set it from C to *b* upon the *Line of Inclination*, and draw *b d parallel* to C D; [15] take in your Compasses C *d*,

C *d*, carry *that* extent, and ſet *one* Foot of the Compaſſes in X, and the *other* will give *e*, draw C *e* for the *Subſtyle*, from *e* erect the *Perpendicular e f*. [16] Take *b d*, and ſet it from *e* to *f*, and draw the Line C *f* for the *Style*, ſo ſhall the *Triangle* C *e f* be the *Style* to be erected *Perpendicular* to the Line C *e* the *Subſtyle*. The Side C *f*, being *parallel* to the *Axis* of the World, and by its *Shadow* is determined the *Hour of the Day*.

For the Hour Lines.

How to draw the Hour Lines.

[1] Chuſe a Point in the *Subſtyle* C *e*, as *g*, thro' which Point, and at *right Angles* to the *Subſtyle*, draw the Line *g h*. [2] Set *one* Foot of the Compaſſes in *g*, and take the *neareſt Diſtance* to the Line C *f*, and turn *that* Foot about to Æ; upon Æ with the *Diſtance* Æ *g*, draw the *Equinoctial Circle*, or ſo much of it as will ſuffice to bring the *Hour Lines* upon the Plane that you have occaſion for: [3] Lay a Ruler to the *Center* at Æ, and to *i*, that is, where the Line *h i* cuts the *Meridian* or 12 *a-clock Line*, and there begin to divide the *Equinoctial Circle* into 24 *equal Parts*; a Ruler laid to Æ and to thoſe *equal* Parts, will divide the Line *h i h unequally*, and give the Places thro' which the *Hour Lines* muſt paſs: *Laſtly*. Lines drawn from the *Center*

CHAP. XV.

of the Dial at C, thro' thoſe *Marks* in the Line *h i*, ſhall be the *true Hour Lines* of *that* Dial; which *Number* as you ſee done in the Figure.

Note, *You may draw your Dial with* Charcoal *or* Black Lead *(that is, the* Preparative Work) *that it may be taken out when you have put on the* Hour-Lines, *ſo that nothing may appear but what is really uſeful.*

All other *Declining Reclining* Dials are made by *the ſame Directions* that are given *in this* above, only by *changing* the *Figures*, &c.

Of an Incliner *Declining from the* South Weſtward.

As *Secondly*. The *Incliner*, *Declining* from the *South Weſtward*, is made by *the ſame Directions*, only the *Quadrant* muſt be drawn on the *other ſide* towards A, which may be beſt conceived by ſuppoſing *this* Dial to be drawn on *oyled Paper*; and looking thro' the Paper, that which on the right ſide of the Paper was an *Inclining* Dial, *Declining* from the *South Eaſtward*, will be an *Inclining* Dial, *Declining* from the *South Weſtward*.

Of a North *Declining* Eaſt *Recliner.*

Thirdly, A *North Declining Eaſt Recliner* is the ſame with a *South Decliner Eaſt*, *Reclining* from the *Zenith*, only the *Horizontal Line* muſt be at the *Bottom* of the Dial; and alſo the *Center* of the *Quadrant* (and

Hour

Hour Lines) must be *above* the Line A B, and towards the *left Hand*, and may be represented by a *South Declining Eaſt* Recliner, turned *Bottom* upwards, with the *ſame ſide* towards you as before. CHAP. XV.

Fourthly. A *North Declining Weſt* Recliner is the ſame with a *South Declining Weſt* Incliner, only (as before) the *Horizontal Line* A B, muſt be at the *Bottom* together with the *Center* of the Dial, and the *Quadrant* muſt be *above the Line*, and towards the *right Hand*, and may be repreſented by the Dial already deſcribed, if imagined to be done upon *oyled Paper*, and ſeen thro', being turned *Bottom upwards*. *Of a North Declining Weſt Recliner.*

N. B. *The* Hours *on the* North *Dials muſt be* numbered *the* contrary way *to thoſe of the* South *Dials.*

CHAP. XVI.

CHAP. XVI.

To make a REFLECTIVE * *Dial.*

Plate 9. *Fig.* 2.

THIS Dial will ſhew the true Hour of the Day by *Reflection* on a *Cieling*, where the *direct* Beams of the Sun can never come, and it will repreſent the *Sun's Motion*, as truly and regularly *within the Houſe*, as his natural Motion is *without*, provided *the Window* open to the *Southward*, or ſo that the Sun might ſhine in or near it.

The Ground or Foundation of Reflective *Dials.*

Theſe ſorts of Dials are grounded upon this Principle in *Opticks*, viz. *that the Angle of* INCIDENCE *is equal to the Angle of* REFLECTION: *that is*, whatever *height* the Sun be at any time, the *ſame height* has the *reflected Spot* upon the Cieling.

This being underſtood, it is eaſy to draw *Hour Lines* upon the *Cieling* of a Room, or upon any other Place though never ſo Irregular, and that the *Hour* by the help of a *Piece* of a *Looking-Glaſs* fixt *Horizon-*

* *Reflective* or *reflecting* Dials, are made by a little piece of Looking-Glaſs duly placed, which reflect the *Sun's Rays* to the top of a Ceiling where the Dial is drawn. *N. B.* The Piece of Glaſs ſhould be as thin as it can well be ground.

tally

tally in a *Window*, or ſome other *convenient Place* for that Purpoſe, may be truly known. CHAP. XVI.

To place the Glaſs.

[1] Having then made choice of a *Window* towards the *South*, that ſo you may have as much of the *Morning* and *Afternoon Sun* as poſſible, take ſpecial care to fix your Glaſs *Horizontal*, otherwiſe your Work will all be ſpoiled.

N. B. All *Great Circles*, as *Equinoctial* and *Hour Circles*, are *ſtreight Lines*, and the *leſſer Circles* as *Tropicks* and *other Parallels of the Sun's Declination* are † *Conick Sections:* and that *this* Dial (when drawn) is no other than a *Horizontal Dial* for the *ſame Latitude inverted*, Plate 9. Fig. 2.

Great Circles *of the Sphere are* ſtreight Lines, *and the* leſſer Circles *are* Conick Sections.

To draw the 12 a-clock Hour Line.

[2] Having then placed a Piece of a *Looking-Glaſs*, about the *bigneſs* of a *Sixpence*, marked thus ⊙ in the *Figure*. *Over this Glaſs* hang a *Plumb Line* at 12 *a-Clock*, this String will caſt a true *Meridian Line* (*i. e.* it is the true 12 *a-clock Hour Line*) upon the Floor.

Of the 12 *a-clock* Hour Line.

† A *Cone* doth ſomewhat reſemble a *Sugar Loaf*, and being cut any where *ſlope-wiſe* is called a *Conic Section*.

CHAP. XVI.

Or if you think that way too difficult, you may find a 12 *a-clock Line* as I have taught in Chap. IV. page 22. This being done, this 12 *a-Clock Line on the Floor*, is to be *transferred* to the *Cieling*, which may be performed by the help of *two* Plumb Lines, *one* held *over the Glaſs* ⊙, and the *other* held *over the other end* of the 12 *a-Clock Line* at A, at the other end of the Room; by this means you will have *two* points on the *Cieling*, juſt over your 12 *a-Clock Line* on the *Floor*, to which *two* Points on the *Cieling* ſtretch *a Line* blacked with *Lamb Black and Oil*, and holding it faſt at both Ends, (as two *Sawyers*, or *Carpenters* generally do a CHALKED LINE) ſtrike the *black* 12 *a-Clock Line* on the *Cieling*, repreſented by A C.

To draw the Equinoctial.

Of the Equinoctial Circle.

[3] Make the *Angle* B ⊙ P, equal to the *Complement of the Latitude* of *the Place*, as ſuppoſe at *Ormſkirk* 36 *Deg.* 30 *Min.* which you muſt do *by a String*, held *one* end to *the Glaſs* ⊙, and the *other* to the *Cieling* repreſented by B ⊙, and applying the *Edge* of your *Quadrant*, till you find the *String and Plummet*, cut the *Limb* at 36 *Deg.* 30 *Min.* thro' *that Point* of the 12 *a-Clock Line*; at B the *Equinoctial Circle* muſt paſs, which draw at *Right Angles* to the 12 *a-Clock Line*

Line A D, and it is a *ſtreight Line* as you ſee in the *Figure*. CHAP. XVI.

To draw the Tropick *of* Cancer.

[4] Then, becauſe the Sun's *greateſt height at* 12 *at Noon*, at *Ormſkirk* is 59 *Deg.* 59 *Min.* make the *Angle* D ⊙ P *equal thereto* by help of your *Quadrant and String* as before: ſo is the *Point* D, the *Point* in the 12 *a-clock Line*, where the *Tropick of Cancer* muſt paſs, which, becauſe it is a *leſſer Circle* of the *Sphere*, it is not a *ſtreight Line* but a *Curve*, which muſt be drawn by help of Table VI; (that is, by having the Sun's height at every Hour the 10th of *June* for the Latitude of your Place;) ſo with an even hand, you may draw the *Tropick of Cancer* G D H. *Of the Tropic of Cancer.*

To draw the Tropic *of* Capricorn.

[5] Becauſe the Sun's *leaſt height at* 12 *at Noon* at *Ormſkirk* is 13 *Deg.* 1 *Min.* make the *Angle* A ⊙ P *equal thereto*, by help of your *Quadrant and String*, ſo ſhall A be the *Point* in the 12 *a-clock Hour Line* on the *Cieling*, where the *Tropick of Capricorn* muſt paſs, and muſt be drawn by the *Table* of the *Sun's Altitude* at *every Hour* upon the 10th of *December* as above directed, ſo that ⊙ D repreſents the *reflected Ray* on the *longeſt Day*; ⊙ B, when *Of the Tropic of Capricorn.*

CHAP. XVI.

he is in the *Equinoctial*, that is, *twice a Year*, viz. on *March* 10th, and *September* 12th, and ⊙ A represents the *reflected Ray* on the *shortest Day*.

To draw the Hour Lines.

Of the Hour Lines *how drawn.*

[6] With any *convenient* opening of your Compasses, draw the *Semicircle* ⊙ L M, and *divide it* into 12 *equal Parts*, because 15 *Deg.* in the *Equinoctial* is *equal* to *one Hour in Time*, as by Table III.

Hence, because the *Center* of the *Dial* doth not fall *in the room*, but *out of it* in the open Air at O, for which reason (before the *Hour Lines* can be drawn) you must find the *Angle* that *each Hour Line* makes with the 12 *a-clock Hour Line*, their *Complements* are what they make with the *Equinoctial*; this is easily done by *Calculation*, but because I have throughout this Treatise laid that Method aside, and kept strictly to a *Mechanick Method*, your best Way will now be to draw an *Horizontal Dial* for the *Latitude* of *Ormskirk*, which is 53 *Deg.* 30 *Min.* as has been taught in *Chap.* IV. and with your *Compasses* and *Line of Chords* measure the *Angles* that the *Hour Lines* make with the *Meridian*, and set them down in a *Table*, as followeth.

Then

Hours.	*Angles with the Meridian.*	*Angles with the Equinoct.*
12	0 0	0 0
1 11	12 10	77 50
2 10	24 54	65 6
3 9	38 47	51 13
4 8	54 19	35 41
5 7	71 34	18 26
6	90 00	0 00

Then with your *Quadrant* lay it to the 12 *a-clock Hour Line*, and *make Angles there* upon the *Cieling equal* to thoſe in the *ſecond Column*, or elſe you may lay it to the *Equinoctial Line* on the *Cieling*, and make the *Angles* of *every Hour* equal to thoſe in the *third Column* of this *Table*, and by help of your *blacked String*, as before directed, draw the *Hour Lines* upon the *Cieling*, which ſhall be the *true Hour Lines* required.

Another *Way to draw the* Hour Lines.

Or if you think this way *too tedious*, when you have your *Horizontal Dial* fitted to *your Latitude*, place the *Center* of your *Horizontal Dial* in the *Center of the Glaſs*, and fix *a Thread* in the *Center of the Dial*; lay the *Thread* ſtreight over *every Hour* of your *Horizontal Dial*, faſten it at the *other ſide* of the *Room*; and ſo transfer them to the *Cieling*, as was ſhewn in drawing the 12 *a-clock Line from the Floor* by help of the *Plumb Lines*; thus have I given you *two* Methods by which you may draw the *Hour Lines* on the *Cieling*, which I leave to the

CHAP. XVI.

judicious Practitioner to make use of which he pleases.

How to make a Table for drawing of the Hour Lines.

The framing of a *Table* of the *Angles* that the *Hour Lines* make with the 12 *a-clock Hour Line* and *Equinoctial*, is made after this manner, *viz.* Suppose I would measure the Angle D ⊙ P in Plate 9. Fig. 2. Take your Compasses and extend on the *Line of Chords* from *the end of the Line* at O to 60 *Deg.* with *that extent* set *one* foot in ⊙, and draw the *Arch* P D; take the said *Arch* P D in your Compasses, and apply it to your *Line of Chords*, and you will find it to contain 59 *Deg.* 59 *Min.* and such is the *Angle* D ⊙ P. And after the same manner is *any other Angle* measured.

CHAP.

CHAP. XVII.

CHAP. XVII.

To make a REFRACTED * *Dial.*

FOR this purpose you must have in readiness an *Horizontal Dial* for the *Latitude of your Place*, and then stick up a *Pin*, or *Wire*, or assign any Point in any *hollow Bowl*, or *Dish*, to shew *the Hour*, and make that the *Center* of your *Horizontal Dial*; then fix upon any Place on the *Edges* of the *Bowl*, or *Dish*, for the 12 *a-clock Hour Line*, and *transfer* the rest of the *Hour Lines* from the *Horizontal Dial* to the *Edge* of the *Bowl*; and taking away the *Horizontal Dial*, hold up a String from *the End* of the *said Pin* fastned thereto, *over* the 12 *a-clock Hour Line* equal to *the Latitude* of your Habitation; and this is done by applying the *Edge* of your *Quadrant* to the *String*, till it *cuts* the *Latitude of the Place* upon the *Limb* thereof.

Then with *a Candle*, by bringing the *Thread* to cast *a Shadow* on any *Hour Point*, just before marked upon the *Edge* of the *Bowl*, *that* Shade in the *Bowl* is the Place to which the *true Hour Line* must be drawn; and if the Bowl be full *of Water*, or *any other Li-*

* *Refracted Dials* are such as shew the *true Hour* only by means of some *refracting* transparent Fluid, such as *Water*, &c.

quor,

CHAP. XVII.

quor, when the *Hour Lines* are drawn, it will never ſhew the *true Hour* by the Shadow of the Top of the Pin, but when the Bowl is filled again with the ſame Liquor †.

† For more particular Satisfaction, ſee my *Aſtronomy* under the Word *Refraction*, Vol. I. Page 38.

CHAP. XVIII.

To make a GLOBE *Dial.*

Plate 10. *Fig.* 1.

THIS Dial is drawn upon a *ſolid Ball* or *Globe*, and ſhews the *Hour* of the Day without a *Style* or *Gnomon*.

How to form the Plane of a Globe Dial.

The manner *of turning* round Balls, is well known to Workmen; but if a large *Stone Ball* is to be made, that cannot be turned becauſe of its *Weight*.

You muſt therefore in the firſt Place form it *globular* with a *Chiſſel*, and then take a wooden or braſs *Semicircle* (as in *Fig.* 2.) of *the ſame* Diameter, as you deſign *your Ball* (the bigger the better;) this being done, turn the *Semicircle* about the Ball, and take away all the *Superfluities* with a *Raſp*, until the *Semicircle every where*, and *every way*, juſt touches the *Superficies* thereof; afterwards make

to Fold out facing page 75

Plate 10

A Globe Dial

Fig. I.

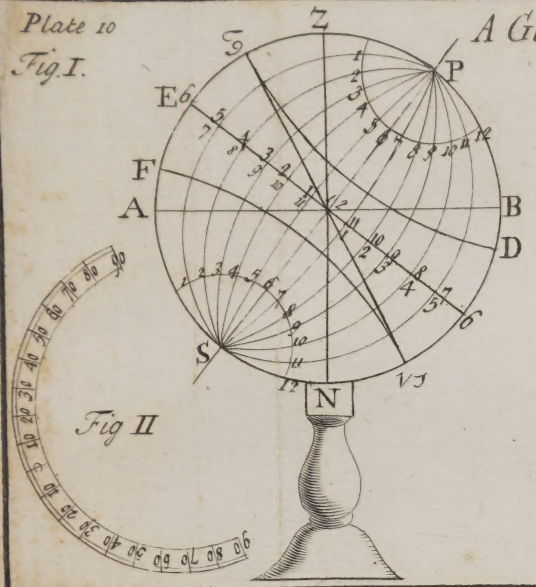
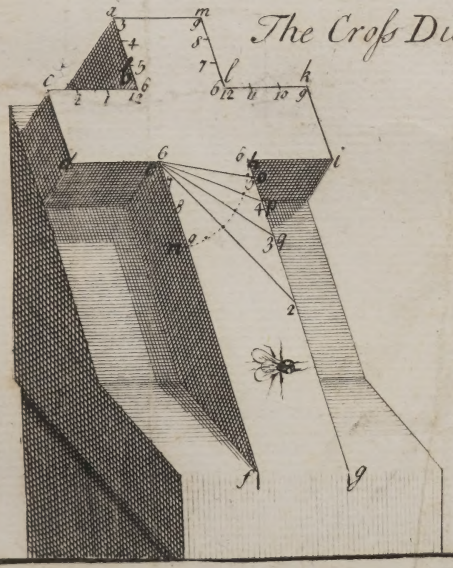


Fig III

The Cross Dial



make it ſmooth with a *Pumice Stone*, or (Sea Dog's) *Fiſh Skin.* CHAP. XVIII.

For the Circles of the Sphere.

The Globe being thus finiſhed, and ſet in your Garden upon a *Pedeſtal*, as *Figure* 1, proceed to draw thereon *the Circles of the Sphere* (by help of a Pair of *Spheric Compaſſes*, or a *Semicircle* that juſt fits *the Globe*) as A B, the *Horizon*, Z N the *prime Vertical*, ſo ſhall Z be your *Zenith*, and N your *Nadir*. Draw P S for the *Earth's Axis* to *any Latitude*, as *ſuppoſe* that of *Dublin* 53 *Deg.* 20 *Min.* ſo ſhall P be the *North Pole*, and S the *South Pole* of the World. Make Z Æ *equal* to B P, and draw Æ æ for the *Equinoctial*, which *divide* into 24 *equal Parts*, and draw the *Hour Circles* or *Meridians* all meeting in the *Poles* of the World.

How to draw the Circles of the Sphere *upon the* Globe Dial.

An Example of a Globe Dial *for* Dublin.

Your *Semicircle* being divided into 180 *Deg.* and *numbred* as you ſee in *Fig.* 2. mark 23 *Deg.* 29 *Min.* from the *Equinoctial* at Æ to ♋ and F, and draw ♋ D for the *Tropic of Cancer*; and F ♑ for the *Tropic of Capricorn*; alſo from the *Poles* at P and S mark (by help of your *Semicircle*) 23 *Deg.* 29 *Min.* and draw the two *Polar Circles*; 12, 12. *Laſtly*, Draw ♋ ♑ for the *Ecliptic*, and thereon place the 12 *Signs of the Zodiac*, beginning at the *Equinoctial*, where the *Ecliptic* cuts it with ♈; at 30 *Degrees*

CHAP. XVIII.

Degrees further, place ♉, at 30 *Degrees* from that, put ♊, at 30 *Degrees* more, put ♋, which will be where the *Ecliptic* cuts the *Tropic of Cancer*, and so on, at every 30 *Degrees* in the *Ecliptic*, place the *Signs* in order thus, ♌, ♍ ♎ ♏ ♐ ♑ ♒ ♓. I have omitted them in the Figure to avoid Confusion.

For the placing *of the* Hours.

The *Hours* must be *numbred* in the *Equinoctial*, placing 12 at the *East* and *West Points* of the *Horizon*, and 6 upon the *Meridian*. Then because *one half* of the *Globe* (nearly) is illuminated when the Sun shines, and the *other half* remains in *Darkness*, and so the *Extremity* of the *Light* shews the *Hour* in two *opposite* Places.

How the Sun shining upon this Globe Dial *would exactly resemble the Sun shining upon the* Earth itself.

If moreover the *different Countries* on the *Earth's Superficies*, as likewise the *principal Cities* were laid down upon the *Globe*, according to their *true Latitudes* and *Longitudes*, you may discover any Moment the Sun shines upon the same, by the *illuminated Part* thereof, what Places on the Earth *are enlightened*, and what Places *are in Darkness*. The *Extremity of the Shadow* shews likewise what Places the *Sun* is *Rising* or *Setting* at; and *what Places* have *long Days*; *these* with many more *curious Problems*

blems are ſeen at one View, too many to be enumerated in this Place. CHAP. XVIII.

This Dial is the *moſt natural* of all others, becauſe it reſembles *the Earth itſelf*, and the *exact* manner of *the Sun's ſhining* thereon.

Note, You may draw as many *Parallels of Declination* upon it as you pleaſe, by the *Table* of the *Sun's Declination.* See Table I.

Alſo if *two Wires* be put in, *one* at P and *another* at S, and 12 at the *Meridian*, and the *Hours numbered* as you ſee, *that Wire* at P, will give the *Hour* in the *Summer*, and that at S the Hour in the *Winter*.

CHAP.

CHAP. XIX.

CHAP. XIX.

To make a CROSS *Dial.*

Plate 10. *Fig.* 3.

A *Croſs Dial* is that which ſhews the *true Hour* of the Day, without a *Style*, by the *Shadow of one Part* of the Dial itſelf, appearing upon *another Part thereof.*

Where one of theſe Dials *may be ſeen.*

There is one of *this* ſort of Dials near the *South-Weſt* Corner of *Middle Moorfields, London* *.

For the making of this Sort *of* Dial.

You need have no regard to the *Latitude of the Place*, for that is to be conſidered in the *placing*, and not in the *making* of it.

[1] In order to which, prepare a Piece of *Wood* or *Stone* of what Size you pleaſe, and ſhape it in the *Form* of a *Croſs*, ſo that *a b, b c, c d, d e, e h, h i, i k, k l, l m,*

* The *Inſcription* upon this Dial being cut in *Iron*, and expoſed to the Weather, it is ſo defaced, that it required much Pains and Art to render it legible, and therefore I deſire the Reader's Excuſe for preſerving it. *This Dial was placed here as a Boundary of the Pariſh of* St Stephens, Coleman-ſtreet, *in the memorable Year* 1706, *and in the fifth Year of the glorious Reign of our moſt gracious Sovereign Queen* Anne, *whom GOD long preſerve.* Robert Trevitt, Painter Fecit.

and

and *m a* may be *all equal*: *e f*, may be *more than double* to *a e*: that in *London* is 25 *Inches*, and 5 *Tenths* of an *Inch long* from *a* to *f*, and *a m* is 4 *Inches* and 8 *Tenths*, *e f* 15 *Inches* and 8 *Tenths*, and the *Depth or Thickneſs* is 6 *Inches*, 8 *Tenths*. This premiſed CHAP. XIX.

[2] Set one Foot of your Compaſſes in *e*, and draw the *Arch* or *Quadrant h n*, which *divide* into *ſix equal Parts*, for *ſix Hours*, becauſe it is a *Quarter of a Circle*; lay a Ruler from the *Center e*, and draw *e o*, *e p*, *e q*.

Of the Poſition of this Dial.

[3] Now the *Poſition* of this Dial being ſuch that *its End a m*, muſt *face* the *South*, and the *upper Part* of it to lie *parallel* with the *Equinoctial*, the *Sun* at 12 *a-clock* will ſhine juſt *along the Line a b* and *m l*. Therefore you muſt place 12 at *b* and *l*, then it is plain that from 12 to 3 *the Shadow* of *the Corner a* will paſs *along the Line b c*; therefore take from the *Quadrant* juſt now drawn *h n the Diſtance h o*, and ſet it from 12 to 1.

[4] Take alſo *h p*, and ſet from 12 to 2, *h q* being equal to *b c*, at *c* place 3, where the *Shadow* of the *Corner a* goes *quite off the Dial at c*, or 3 in the *Afternoon*; but then *the Shadow* of the *Corner i*, will come on *the Side h g* at *q*, or 3 a-clock, where place the *Figure* 3; at *p* 4, at *o* 5, and at *h* 6 in the *very Corner*: becauſe at 6 the Sun will

CHAP. XIX.

ſhine *right along* the Line *i h*; place 6 alſo at *the Corner l*, becauſe the Sun at 6 ſhines *right along* the Line *l k*, and from 6 till 9, (if it be in a *Latitude* where the Sun continues up ſo late at Night) the *Shadow* of *the Corner* at *k* is paſſing *along* the Line *l m*.

[5] Therefore take in your Compaſſes the *Diſtance h o*, and ſet from 6 to 7.

[6] Take *h p*, and ſet from 6 to 8 along the Line *l m*; and the *Diſtance h q* is *equal* to *l m*; therefore at *the Corner m*, place 9, becauſe the *Shadow* of *the Corner k*, *goes off* the Line *l m* at 9.

[7] Then for the *Morning Hours* the *Shadow* of the *Point c* will enter upon the Line *a b* at the *Point a*, juſt at 3 in *the Morning*; therefore *draw Lines* from 7 and 8 in the Line *l m*, which let be drawn *parallel* to *a m*, and having placed 3 at *the Corner a*, place 4 right againſt 8, 5 againſt 7, ſo will 6 be in *the Corner b*, becauſe at 6 the Sun ſhines juſt along the Line *c b*, and from 6 till 9 the *Shadow* of the *Point d* is paſſing along the Side *e f*.

[8] Therefore having placed 6 in *the Corner e*, *draw Lines* from the Points *o p q*, parallel to *d i*, and at *thoſe Points* put the Figures 7, 8, 9, for when *the Shadow* of the *Point d* comes to 9; the *Shadow* of *the Point m* is at the *Point k*, and from 9 to 12 the *Shadow* of *m* paſſeth along the Line *k l*, and at 12 the *Shadow* of *m*, is come to *l*.

[9] There-

[9] *Therefore* take the *Diſtances h o, h p, h q*, and ſet them from *l*, to 11 and 10, the *Diſtance h q* being *juſt equal* to *l k*, and thus is the Dial finiſhed. CHAP. XIX.

The Sun as it *goes off* from *one Part* of it *comes on* to *another Part* thereof; ſo that the Time of the Day may *always* be found upon *ſome Part* or *other* of it, when the Sun ſhineth.

Why theſe Dials require Thickneſs.

The Reaſon why theſe Dials require *Thickneſs*, as well as other *Dimenſions*, is, becauſe being placed *parallel to the Equinoctial*, the Sun ſhines upon the *upper Face* all the *Summer*, and on the *longeſt Day* is *elevated* 23 *Deg.* 29 *Min. above* the Plane of the Dial, and *conſequently* the *Shadow* of *a* will fall at *Noon* in *the Line a b*, and not in *the Point b*, but at an *Angle* of 23 *Deg.* 29 *Min.* therewith, (that being the Sun's greateſt Declination on the longeſt Day.) And on the *ſhorteſt Day* the *Shadow* of *a*, will be *below* the Plane or Line *a b*, and make an *Angle* of 23 *Deg.* 29 *Min.*

How you muſt ſet this Dial truly.

This Dial *is univerſal*, for when you have made one, according to the above Directions, there is nothing to do but to fix it in your Garden, *&c.* by help of your *Quadrant* to the *Elevation of the Equinoctial*, or *Complement of the Latitude of your Habitation*, and ſo that the Side *a b* may *exactly* face the *South*.

CHAP. XIX.

If you would place this Dial in any Place *within the Polar Circles*, you muſt then make all the *Ends* of an *equal* length, *viz. e f*, &c. *equal* to *a b*; otherwiſe, the Shadow would quit one Side before it comes on another, as you may the better perceive by viewing the Figure in *Plate* X. *Fig.* 3.

What to be obſerved if this Dial were to be placed within the Polar Circles.

Thus having in the foregoing Work ſhewn how to make all manner of uſeful Dials, I think it only remains now to ſhew how

To make a WINDOW *Dial.*

This is a very uſeful Dial, for by it you may know the Hour of the Day tho' the Sun *doth not ſhine outbright*, but appears ever ſo little thro' the Clouds: And ſo you may in the Night by the *Stars*, and *Moon*.

If your Window face any Point of *the Compaſs*, *near* the *South* (is beſt) then find its *Declination*, as has been taught in *Chap.* X. and upon a good Sheet of Paper draw the draught of your Dial, as has been taught in *Chap.* XI.

Place *the Center* of your Paper Dial upon the *Window Frame* juſt over the Glaſs, in *the very Place* where you deſign to fix the *Style*, that the 12 *a-clock Hour Line* may fall ſtreight down the *Window*; and by help of a *String*, or *Ruler*, mark the Hours

from your *Paper draught* upon the Window. CHAP. XIX.

Then get an *Iron Rod* about *the Thickneſs* of your *Hour Lines*, and nail it to the Window Frame *exactly* in *that Place* where the *Center* of your *Paper draught* was placed, and ſet it to the *Latitude of your Place* by help of your *Quadrant*, which is done by putting *that Edge* of it to the *Style* wherein the *Sights* are, and raiſing the *Style* higher or lower till the Thread cut *the Limb* in the *Degree* of *the Latitude of your Place*; and there faſten it at *right Angles* over the *Sub-ſtyle Line*.

You may put Figures (or any Marks for your own Information) to the *Hour Lines*, and thus is your Dial finiſhed.

And, how pleaſant this will be, to ſit in your Houſe, *&c.* to ſee the Time of the Day that the Sun ſhines upon the Window, will beſt appear from the Dial when thus made: ſince at any Time when you can ſee the Sun juſt *thro' the Clouds*, you may then tell the Hour of the Day as well as if it ſhined *ever ſo bright*; for look thro' the *Window* and take the Style *between your Eye and the Sun*, and at the ſame Time you'll ſee the Hour where the *Style*'s ſhade will fall upon the Window, and that is the true Hour of the Day.

Alſo, in the Night you may do the ſame by any *known Star*, by firſt knowing the

CHAP. XIX.

Time the Star will be upon the *Meridian* or *South*, and as much as it wants of the *South* by the Dial *ſubſtracted* from the Time of *Southing*, gives the *true Hour* of *the Night*, but if it be *paſt* the *South* by the Dial, add ſo much to the Time of *Southing*, and you have the Time of the *Night*. The ſame Method is to be uſed for the Time of the Night by the *Moon*.

This Method of *transferring* the *Hour Lines* from your *proper draught*, is what you may uſe in making of any Dial, which I recommend as being moſt practicable.

TABLE

TABLE I.

A TABLE of the *Sun's Declination* exactly calculated for the Year 1738, which (for the Use of Dialling) will serve for this Age without any sensible Error.

Note { D. M. N. S. } stand for { Degrees Minutes North South }

TABLE I.

A TABLE of the *Sun's Declination.*

	Jan.		*Feb.*		*Mar.*		*April*		*May*		*June*	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	21 S	39	13 S	39	3 S	17	8 N	43	18 N	10	23 N	11
2	21	29	13	19	2	53	9	4	18	24	23	15
3	21	18	12	59	2	29	9	26	18	39	23	18
4	21	8	12	38	2	6	9	48	18	54	23	21
5	20	56	12	18	1	42	10	4	19	7	23	23
6	20	44	11	57	1	18	10	30	19	21	23	25
7	20	32	11	36	0	55	10	51	19	35	23	27
8	20	20	11	14	0	31	11	12	19	48	23	28
9	20	7	10	53	0	7	11	33	20	0	23	29
10	19	54	10	31	0 N	17	11	53	20	13	23	29
11	19	40	10	9	0	40	12	13	20	25	23	29
12	19	26	9	47	1	4	12	34	20	36	23	28
13	19	11	9	25	1	28	12	54	20	48	23	27
14	18	57	9	3	1	51	13	13	20	59	23	26
15	18	42	8	40	2	14	13	32	21	9	23	24
16	18	26	8	18	2	38	13	52	21	19	23	22
17	18	11	7	55	3	2	14	11	21	29	23	20
18	17	54	7	33	3	25	14	29	21	39	23	17
19	17	38	7	10	3	48	14	48	21	48	23	13
20	17	21	6	47	4	11	15	6	21	57	23	9
21	17	4	6	23	4	35	15	24	22	5	23	5
22	16	47	6	1	4	58	15	42	22	13	23	1
23	16	29	5	37	5	21	15	59	22	21	22	56
24	16	12	5	14	5	44	16	17	22	28	22	50
25	15	53	4	51	6	6	16	34	22	35	22	44
26	15	35	4	27	6	29	16	50	22	41	22	38
27	15	16	4	4	6	52	17	7	22	47	22	32
28	14	57	3	40	7	14	17	23	22	53	22	25
29	14	38	———		7	37	17	39	22	58	22	17
30	14	19	———		7	59	17	54	23	3	22	10
31	13	59	———		8	21	———		23	7	———	

TABLE I.

A TABLE of the *Sun's Declination.*

	July		*Aug.*		*Sept.*		*Octob.*		*Novem.*		*Decemb.*	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	22N	1	15N	1	4N	12	7S	26	17S	46	23S	8
2	21	53	14	43	3	49	7	48	18	3	23	12
3	21	44	14	25	3	25	8	11	18	18	23	16
4	21	35	14	6	3	2	8	33	18	33	23	19
5	21	25	13	47	2	39	8	56	18	48	23	22
6	21	15	13	28	2	16	9	17	19	3	23	24
7	21	4	13	9	1	53	9	40	19	18	23	26
8	20	54	12	49	1	29	10	1	19	32	23	28
9	20	43	12	29	1	6	10	23	19	45	23	29
10	20	32	12	10	0	42	10	45	19	59	23	29
11	20	20	11	50	0	19	11	6	20	12	23	29
12	20	8	11	29	0S	4	11	27	20	25	23	28
13	19	55	11	9	0	28	11	48	20	37	23	27
14	19	43	10	48	0	51	12	9	20	49	23	26
15	19	30	10	27	1	15	12	30	21	1	23	24
16	19	16	10	6	1	38	12	50	21	12	23	22
17	19	3	9	45	2	2	13	10	21	22	23	19
18	18	48	9	24	2	25	13	30	21	33	23	16
19	18	34	9	2	2	49	13	50	21	43	23	12
20	18	19	8	40	3	12	14	10	21	52	23	8
21	18	4	8	19	3	36	14	29	22	1	23	3
22	17	49	7	57	3	59	14	49	22	10	22	58
23	17	34	7	35	4	22	15	7	22	18	22	52
24	17	18	7	12	4	45	15	26	22	26	22	46
25	17	2	6	50	5	9	15	45	22	33	22	39
26	16	45	6	28	5	32	16	2	22	40	22	32
27	16	29	6	5	5	54	16	20	22	47	22	25
28	16	12	5	43	6	18	16	38	22	53	22	17
29	15	55	5	20	6	40	16	55	22	58	22	9
30	15	37	4	57	7	3	17	13	23	3	22	0
31	15	19	4	35			17	29			21	51

THE

Explanation and Uſe

Of the foregoing

TABLE.

THIS Table ſhew you the *Sun's Declination* * every Day *at Noon*, and is exactly calculated to the *Year* 1738 to the *Meridian of London*, which will ſerve for *this Age near enough* for any Purpoſe in *Dialling*.

The *Letter* N ſtands for *North* Declination, and S for *South*.

It is of good uſe to find the *Latitude of the Place* of your Habitation: this may be done by taking the height of the Sun at *Noon* with your *Quadrant*: and if the *Sun's Declination* be *South*, ADD it to the *Altitude* or height at *Noon*, but if it be *North* SUBSTRACT: the Sum or Difference is the *height* of the *Equinoctial* or *Complement of the Latitude* in the *Northern* Hemiſphere, but in the *Southern* uſe the contrary Titles.

Example.

* The *Declination of the Sun* is his *Diſtance* from the *Equinoctial*, and in all Things of *this kind* the *Sun* is ſuppoſed to move *parallel* to the *Equinoctial* all *that* Day, and tho' it does not ſo in fact, yet it ſerves in Dialling *near enough* the Truth: and this *Declination* never exceeds 23 *Deg.* 29 *Min.* as appears by the Table.

Example.

Admit you are at a certain Place in the *North* of *England*, &c. and upon the 14th of *February* you observe the *Sun's height* at *Noon* with your *Quadrant* to be 26 *Deg.* 30 *Min.* what is the *Latitude of Observation?*

Operation.	*Deg.*	*Min.*
To the *Sun's Altitude* observed ——	26	30
Add the *Sun's Declination* S. ——	9	3
Sum is the *height of Equinoctial* —	35	33
Subtract it from a *Quadrant* or ——	90	00
The Latitude of the Place *North* is —	54	27

Example 2.	*Deg.*	*Min.*
From the *Sun's Altitude* observed ——	44	51
Subtract the *Sun's Declination* North	10	51
Remains the *Complement of the Latitude*	34	00
Subtract from a *Quadrant* or ——	90	00
Remains the *Latitude North* ——	56	00

TABLE II.

A TABLE of the *Equation of Time* for the Regulating of Clocks and Watches by a Sun-Dial.

TABLE II.

A TABLE for *Regulating* Pendulum Clocks, *&c.* with the Sun Dials.

	Jan.		*Feb.*		*Mar.*		*April*		*May*		*June*	
	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
1	8	58	14	48	10	8	0	50	4	2	0 +	50
2	9	21	14	47	9	51	0	34	4	4	0	37
3	9	43	14	45	9	34	0	18	4	5	0	25
4	10	5	14	42	9	17	0	2	4	5	0	13
5	10	26	14	38	9	0	0 +	3	4	4	0 —	1
6	10	45	14	33	8	42	0	28	4	3	0	11
7	11	4	14	28	8	24	0	42	4	2	0	24
8	11	22	14	22	8	5	0	56	4	0	0	37
9	11	40	14	16	7	47	1	10	3	58	0	50
10	11	57	14	9	7	29	1	23	3	56	1	3
11	12	14	14	1	7	11	1	36	3	53	1	16
12	12	30	13	52	6	52	1	48	3	49	1	29
13	12	44	13	43	6	33	2	0	3	44	1	42
14	12	58	13	34	6	15	2	11	3	38	1	55
15	13	11	13	24	5	56	2	21	3	32	2	7
16	13	23	13	13	5	37	2	31	3	25	2	20
17	13	35	13	2	5	19	2	41	3	18	2	32
18	13	46	12	50	5	1	2	51	3	11	2	44
19	13	56	12	37	4	42	3	0	3	4	2	56
20	14	5	12	28	4	23	3	8	2	56	3	8
21	14	13	12	12	4	4	3	15	2	47	3	19
22	14	20	11	58	3	45	3	22	2	38	3	30
23	14	26	11	43	3	27	3	29	2	29	3	41
24	14	32	11	28	3	9	3	35	2	19	3	52
25	14	37	11	13	2	51	3	41	2	9	4	2
26	14	41	10	58	2	33	3	46	1	59	4	12
27	14	44	10	42	2	15	3	50	1	48	4	22
28	14	46	10	25	1	57	3	54	1	37	4	31
29	14	47			1	40	3	57	1	26	4	40
30	14	48			1	23	4	0	1	14	4	48
31	14	49			1	6			1	3		

Clocks too faft, faft, faft, faft. Clocks too flow, flow, flow, flow. Clocks too add to the equal Time. Clocks too fubt. from the equal Time.

TABLE II.

A TABLE for *Regulating* Pendulum Clocks, *&c.* with the Sun Dials.

	July		*Aug.*		*Sept.*		*Octob.*		*Novem.*		*Decemb.*	
=	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
1	4	57	4	34	3	55	13	28	15	34	5	47
2	5	5	4	24	4	16	13	41	15	26	5	18
3	5	12	4	14	4	37	13	54	15	16	4	49
4	5	19	4	3	4	58	14	9	15	5	4	20
5	5	25	3	52	5	19	14	21	14	54	3	50
6	5	31	3	40	5	40	14	33	14	42	3	21
7	5	36	3	27	6	1	14	44	14	30	2	51
8	5	41	3	13	6	22	14	54	14	16	2	21
9	5	45	2	59	6	43	15	4	14	1	1	51
10	5	48	2	45	7	4	15	14	13	46	1	21
11	5	50	2	31	7	25	15	23	13	30	0	51
12	5	52	2	16	7	45	15	32	13	13	0	21
13	5	54	2	1	8	5	15	40	12	55	0	9
14	5	56	1	45	8	25	15	46	12	37	0	39
15	5	57	1	29	8	45	15	52	12	18	1	9
16	5	57	1	12	9	5	15	57	11	59	1	39
17	5	55	0	55	9	25	16	1	11	39	2	9
18	5	53	0	38	9	45	16	5	11	18	2	38
19	5	51	0	20	10	5	16	8	10	56	3	7
20	5	49	0	+ 2	10	24	16	10	10	33	3	36
21	5	46	0	16	10	43	16	12	10	10	4	5
22	5	43	0	34	11	2	16	14	9	46	4	34
23	5	39	0	53	11	20	16	13	9	21	5	2
24	5	34	1	13	11	38	16	12	8	56	5	29
25	5	29	1	33	11	55	16	10	8	30	5	56
26	5	22	1	53	12	12	16	7	8	4	6	23
27	5	15	2	13	12	28	16	3	7	38	6	50
28	5	8	2	33	12	44	15	59	7	11	7	16
29	5	1	2	54	12	59	15	54	6	46	7	41
30	4	53	3	15	13	14	15	48	6	16	8	5
31	4	44	3	35			15	41			8	29

Clocks too fast, subt. from equal Time.

Clocks too slow add. equal Time.

Clocks too slow, add equal Time.

Clocks too fast, subt. from equal Time.

THE

Explanation and Uſe

Of the foregoing

TABLE.

THIS is a Table of *Equation of Time*, that is, it ſhews you what the Sun *gains* or *loſes* of the Pendulum Clock *every Day*; for the *Pendulum Clock* keeps *equal Time* all the Year round, tho' the *Sun* doth not do ſo, but is *very unequal* in its Motion, *ſometimes too faſt*, and at other Times *too ſlow*, as the Table plainly ſhews; ſo that if at any Time you want to ſet your *Clock* or *Watch* by your *Sun-Dial*, you muſt look into this Table, and obſerve what the *Equation* is on that Day, and ſet it accordingly, ſo many *Minutes* and *Seconds*, more or leſs, as you ſee the Clock is *too faſt* or *ſlow* for the *Sun*.

For Inſtance, *January* 3d at *Noon*, I ſee the *Clock* is 9 *Min.* 43 *Seconds too faſt* for the *Sun*, &c.

Note, *In this Table this Mark* + *ſignifies Addition and* — *Subſtraction.*

TABLE

TABLE III.

A TABLE for converting *Hours* and *Minutes* of *Time* into *Degrees* and *Minutes* of the *Equinoctial*, and for the turning of *Degrees* and *Minutes* of the *Equinoctial* into *Hours* and *Minutes* of *Time*.

TABLE III.

A TABLE for turning *Hours* and *Minutes* into *Degrees* of the Equinoctial and *è contra*.

H	°	′	°	′	′	°	′	′	°	′
′	′	″	′	″	″	′	″	″	′	″
″	″	‴	″	‴	‴	″	‴	‴	″	‴
1	15	1	0	15	21	5	15	41	10	15
2	30	2	0	30	22	5	30	42	10	30
3	45	3	0	45	23	5	45	43	10	45
4	60	4	1	0	24	6	0	44	11	0
5	75	5	1	15	25	6	15	45	11	15
6	90	6	1	30	26	6	30	46	11	30
7	105	7	1	45	27	6	45	47	11	45
8	120	8	2	0	28	7	0	48	12	0
9	135	9	2	15	29	7	15	49	12	15
10	150	10	2	30	30	7	30	50	12	30
11	165	11	2	45	31	7	45	51	12	45
12	180	12	3	0	32	8	0	52	13	0
13	195	13	3	15	33	8	15	53	13	15
14	210	14	3	30	34	8	30	54	13	30
15	225	15	3	45	35	8	45	55	13	45
16	240	16	4	0	36	9	0	56	14	0
17	255	17	4	15	37	9	15	57	14	15
18	270	18	4	30	38	9	30	58	14	30
19	285	19	4	45	39	9	45	59	14	45
20	300	20	5	0	40	10	0	60	15	0
21	315									
22	330									
23	345									
24	360									

Note { H ° ′ ″ ‴ } ſtand for { Hours, Degrees, Minutes, Seconds, Thirds }

THE

Explanation and Uſe

Of the foregoing

TABLE.

THIS Table ſhews how to convert *Time into Motion*, and *Motion into Time*; as ſuppoſe I had 5 *Hours* 13 *Min.* 29 *Seconds* to be turned into *Degrees* and *Minutes* of the *Equinoctial*, i. e. into *Motion*; the *Operation* ſtands thus.

		°	′	″	
5 *Hours*	=	75	0	0	}
13 *Minutes*	=	3	15	0	} add
29 *Seconds*	=	0	7	15	}
The *Sum*	—	78	22	15	for anſwer.

Again,

Again, ſuppoſe I would turn 78 *Deg.* 22 *Min.* 15 *Seconds* into *Time*, then the Work will ſtand *thus.*

		h	*'*	*''*	
Degrees 75	=	5	0	0	
Degrees 3	=	0	12	0	add
Minutes 15	=	0	1	0	
Minutes 7	=	0	1	28	
Seconds 15	=	0	0	1	
The *Sum*		5	13	29	for anſwer.

TABLE

TABLE IV.

A TABLE of *Meridional Angles*, ſhewing the *Degrees* of each *Hour Line* from 12 *a-Clock*, upon all *Horizontal* and *North* and *South* Erect Direct *Reclining* and *Inclining* Dials, from the *Equinoctial* to the *Poles*.

TABLE IV.

A TABLE of *Meridional Angles.*

Hor. Dial Lat.	XI I		X II		IX III		VIII IV		VII V		VI		South Dial Lat.
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
0	0	00	0	00	0	00	0	0	0	0	0	0	90
1	0	16	0	34	1	00	1	44	3	44	90	0	89
2	0	32	1	9	2	00	3	27	7	25	90	0	88
3	0	48	1	44	3	00	5	11	11	3	90	0	87
4	1	5	2	19	4	00	6	54	14	36	90	0	86
5	1	20	2	52	4	58	8	35	18	1	90	0	85
6	1	36	3	27	5	58	10	16	21	19	90	0	84
7	1	52	4	3	6	57	11	55	24	27	90	0	83
8	2	8	4	37	7	55	13	33	27	23	90	0	82
9	2	23	5	9	8	54	15	10	30	17	90	0	81
10	2	40	5	43	9	51	16	44	32	55	90	0	80
11	2	55	6	17	10	48	18	17	35	27	90	0	79
12	3	11	6	51	11	45	19	40	37	49	90	0	78
13	3	27	7	24	12	41	21	17	40	1	90	0	77
14	3	43	7	57	13	36	22	44	42	4	90	0	76
15	3	58	8	30	14	31	24	0	44	0	90	0	75
16	4	13	9	2	15	25	25	31	45	49	90	0	74
17	4	29	9	35	16	26	26	52	47	27	90	0	73
18	4	44	10	8	10	10	28	9	49	4	90	0	72
19	4	59	10	39	18	2	29	25	50	33	90	0	71
20	5	14	11	10	18	53	30	39	51	55	90	0	70
21	5	29	11	41	19	44	31	50	53	9	90	0	69
22	5	44	12	12	20	32	32	58	54	21	90	0	68
23	5	59	12	43	21	20	34	5	55	30	90	0	67
24	6	14	13	13	22	8	35	10	56	37	90	0	66
25	6	28	13	43	22	55	36	12	57	34	90	0	65
26	6	42	14	12	23	40	37	13	58	34	90	0	64
27	6	56	14	41	24	25	38	11	59	27	90	0	63
28	7	10	15	10	25	9	39	7	60	17	90	0	62
29	7	24	15	40	25	52	40	2	61	4	90	0	61
30	7	38	16	6	26	33	40	54	61	49	90	0	60

TABLE IV.

A TABLE of *Meridional Angles.*

Hor. Dial Lat.	XI		I		X		II		IX		III		VIII		IV		VII		V		VI		South Dial Lat.
	D.		M.		D.		M.		D.		M.		D.		M.		D.		M.		D.	M.	
31	7		50		16		34		27		15		41		44		62		30		90	0	59
32	8		5		17		1		27		55		42		30		63		11		90	0	58
33	8		19		17		27		28		34		43		20		63		49		90	0	57
34	8		31		17		54		29		13		44		5		64		24		90	0	56
35	8		44		18		20		29		50		44		49		64		58		90	0	55
36	8		57		18		49		30		27		45		31		65		30		90	0	54
37	9		10		19		9		31		2		46		12		66		10		90	0	53
38	9		22		19		34		31		37		46		50		66		29		90	0	52
39	9		34		19		58		32		11		47		28		66		56		90	0	51
40	9		45		20		21		32		44		48		7		67		21		90	0	50
41	9		57		20		44		33		16		48		39		67		47		90	0	49
42	10		10		21		7		33		46		49		12		68		11		90	0	48
43	10		22		21		29		34		18		49		44		68		33		90	0	47
44	10		32		21		51		34		47		50		10		68		54		90	0	46
45	10		44		22		12		35		17		50		46		69		15		90	0	45
46	10		54		22		33		35		44		51		15		69		35		90	0	44
47	11		5		22		53		36		11		51		42		69		53		90	0	43
48	11		16		23		13		36		37		52		9		70		11		90	0	42
49	11		25		23		33		37		3		52		35		70		28		90	0	41
50	11		35		23		52		37		28		53		0		70		43		90	0	40
51	11		45		24		9		37		52		53		24		70		59		90	0	39
52	11		55		24		27		38		15		53		46		71		13		90	0	38
53	12		5		24		43		38		37		54		12		71		28		90	0	37
54	12		13		25		2		38		58		54		29		71		41		90	0	36
55	12		22		25		18		39		19		54		49		71		54		90	0	35
56	12		32		25		34		39		40		55		9		72		5		90	0	34
57	12		40		25		50		39		50		55		28		72		17		90	0	33
58	12		45		26		5		40		1		55		45		72		28		90	0	32
59	12		56		26		20		40		36		56		3		72		38		90	0	31
60	13		4		26		34		40		54		56		19		72		48		90	0	30

TABLE IV.

A TABLE of *Meridional Angles.*

Hor. Dial Lat.	XI I		X II		IX III		VIII IV		VII V		IV		South Dial Lat.
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
61	13	11	26	47	41	10	56	34	72	58	90	0	29
62	13	19	27	1	41	21	56	49	73	7	90	0	28
63	13	26	27	13	41	42	57	3	73	15	90	0	27
64	13	32	27	25	41	57	57	17	73	24	90	0	26
65	13	36	27	37	42	15	57	30	73	32	90	0	25
66	13	46	27	49	42	25	57	43	73	39	90	0	24
67	13	51	27	59	42	38	57	54	73	46	90	0	23
68	13	57	28	9	42	50	58	5	73	53	90	0	22
69	14	3	28	19	43	2	58	16	73	59	90	0	21
70	14	7	28	29	43	13	58	26	74	5	90	0	20
71	14	13	28	37	43	18	58	35	74	11	90	0	19
72	14	18	28	46	43	24	58	44	74	16	90	0	18
73	14	22	28	54	43	36	58	52	74	20	90	0	17
74	14	27	29	2	43	52	59	00	74	25	90	0	16
75	14	30	29	7	44	00	59	7	74	30	90	0	15
76	14	33	29	15	44	8	59	15	74	34	90	0	14
77	14	37	29	21	44	14	59	22	74	37	90	0	13
78	14	41	29	27	44	22	59	27	74	40	90	0	12
79	14	44	29	32	44	28	59	32	74	44	90	0	11
80	14	47	29	37	44	34	59	37	74	47	90	0	10
81	14	49	29	41	44	37	59	40	74	49	90	0	9
82	14	51	29	45	44	40	59	44	74	51	90	0	8
83	14	53	29	49	44	44	59	47	74	53	90	0	7
84	14	55	29	52	44	48	59	51	74	55	90	0	6
85	14	56	29	54	44	53	59	54	74	57	90	0	5
86	14	57	29	55	44	55	59	55	74	58	90	0	4
87	14	58	29	56	44	56	59	56	74	58	90	0	3
88	14	59	29	57	44	57	59	58	74	59	90	0	2
89	14	59	29	58	44	58	59	59	74	59	90	0	1
90	15	00	30	00	45	00	60	00	75	00	90	0	0

THE
Explanation and Uſe
Of the foregoing
TABLE.

THIS is a Table of *Meridional Angles*; the *firſt Column* is the *Latitude*, which ſerves for an *Horizontal Dial*, and the *laſt Column* is the *Complement of the Latitude*, and is for making *Erect Direct* SOUTH, or NORTH Dials, and are thus to be uſed: ☞ Suppoſe in the *Latitude* of 53 *Deg.* I would make an *Horizontal*, and alſo an *Erect Direct* South Dial.

Firſt, *For the* Horizontal *Dial.*

See Plate 3. Fig. 2.

Concerning an Horizontal *Dial.*

Now (altho' this be projected for a *higher* Latitude, yet it may ſerve our Turn here well enough to ſhew how to uſe the Table:) I look into the Table and find againſt 53 *Deg.* and under 11 and 1 a-clock 12 *Deg.* 5 *Min.* Take this 12 *Deg.* 5 *Min.* in your Compaſſes (from *the Line of Chords*, that

you draw the *Quadrant* A B by) and ſet *one* foot in the *Meridian* C A, and turning the *other* each Way, it ſhall give the *Points* where the *Hour Lines* of 1 and 11 muſt paſs; under 10 and 2: and againſt the *ſame Latitude* 53, I find 24 *Deg.* 43 *Min.* which take from *the Line of Chords*, and ſet *each Way* from the *Meridian* as before, and it gives the 10 and 2 *a-clock Hour Lines.* For the Hours 9 and 3 you muſt take 38 *Deg.* 37 *Min.* for 8 and 4 a-clock, you muſt ſet 54 *Deg.* 12 *Min.* and for 5 and 7 ſet 71 *Deg.* 28 *Min.* the *Chord* of 90 gives the 6 a-clock *Hour Line*, and ſo by drawing *Hour Lines* from the Center *thro'* theſe Points, thus ſet off in the *Arch* A B, are the true *Hour Lines* required.

Secondly, *For the Erect Direct* South *Dial*

See Plate 4. Fig. 2.

Concerning an Erect Direct South Dial.

Suppoſe I would make an *Erect Direct South* Dial for the *Latitude* of 53 *Deg.* the Work in this is the very ſame as I have ſhewed in the *Horizontal Dial*; only here you muſt ſeek your *Latitude* in the *laſt* Column on the *right Hand*, or its *Complement* on the *left Hand*; and againſt either, for 1 and 1 a-clock, 9 *Deg.* 10 *Min.* for 10 and 2, 19 *Deg.* 9 *Min.* are to be ſet off from the *Meridian* by your *Line of Chords*; from [illegible] and

and 3 a-clock are 31 *Deg.* 2 *Min.* for 8 and 4 a-clock are 46 *Deg.* 12 *Min.* for 7 and 5 a-clock are 66 *Deg.* 10 *Min.* and for 6 a-clock are 90; and thus for any *Latitude* of *even Degrees*, an *Horizontal* and *South Direct* Dial may be expeditiously made by help of this *Table* and your *Line of Chords*.

What has been said of the *South* Erect Dial is also applicable to the *North*, and therefore needs no Example.

TABLE V.

A TABLE of the *Three Requiſites* in *Dialling*, ſhewing the *Subſtyle's Diſtance* from the *Meridian*, the *Style's Height*, and the *Inclination of Meridians* for the *Latitude* of *London*; anſwerable to the ſeveral *Degrees* of *Declination* of your *Plane*.

N. B. *How to find* theſe Requiſites *for any* other *Place, is ſhewn in* Chap. XI.

TABLE V.

A TABLE of the *Three Requisites* in *Dialling*.

Declination.	Substyle's Distance from the *Meridian*.		Style's Height.		Inclination of *Meridians*.	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
1	0	48	38	29	1	17
2	1	36	38	28	2	33
3	2	23	38	26	3	49
4	3	11	38	23	5	7
5	3	58	38	20	6	23
6	4	45	38	15	7	39
7	5	32	38	10	8	55
8	6	19	38	4	10	11
9	7	5	37	57	11	27
10	7	52	37	49	12	42
11	8	38	37	40	13	57
12	9	23	37	30	15	10
13	10	8	37	21	16	26
14	10	54	37	10	17	40
15	11	38	36	58	18	54
16	12	22	36	43	20	7
17	13	5	36	32	21	20
18	13	42	36	18	22	33
19	14	31	36	3	23	45
20	15	13	35	48	24	57
21	15	54	35	31	26	8
22	16	36	35	16	27	18
23	17	16	34	57	28	29
24	17	56	34	39	29	38
25	18	37	34	21	30	47

TABLE V.

A TABLE of the *Three Requisites* in *Dialling*.

Declination.	Substyle's Distance from the *Meridian*.		Style's Height.		Inclination of *Meridians*.	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
26	19	12	34	1	31	56
27	19	50	33	42	33	4
28	20	27	33	20	34	12
29	21	5	32	59	35	19
30	21	40	32	37	36	25
31	22	15	32	15	37	31
32	22	50	31	52	38	36
33	23	25	31	27	39	41
34	23	59	31	4	40	46
35	24	31	30	40	41	49
36	25	4	30	14	42	52
37	25	35	29	48	43	55
38	26	4	29	22	44	58
39	26	35	28	56	45	59
40	27	3	28	29	47	0
41	27	33	28	1	48	0
42	28	1	27	33	49	0
43	28	29	27	5	50	0
44	28	55	26	36	50	59
45	29	21	26	7	51	57
46	29	46	25	37	52	55
47	30	11	25	7	53	53
48	30	35	24	38	54	50
49	30	58	24	6	55	46
50	31	21	23	35	56	42

TABLE V.

A TABLE of the *Three Requisites* in *Dialling*.

Declination.	Substyle's Distance from the *Meridian*.		Style's Height.		Inclination of *Meridians*.	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
51	31	45	23	4	57	38
52	32	5	22	32	58	33
53	32	26	22	00	59	28
54	32	46	21	28	60	23
55	33	6	20	55	61	17
56	33	24	20	22	62	10
57	33	42	19	49	63	4
58	34	0	19	16	63	57
59	34	13	18	42	64	49
60	34	33	18	6	65	41
61	34	47	17	34	66	33
62	35	5	17	0	67	24
63	35	18	16	25	68	16
64	35	32	15	50	69	7
65	35	45	15	15	69	57
66	36	00	14	40	70	47
67	36	13	14	5	71	38
68	36	25	13	29	72	27
69	36	36	12	53	73	16
70	36	45	12	11	74	6

TABLE V.

A TABLE of the *Three Requisites* in *Dialling*.

Declination.	Substyle's Distance from the *Meridian*.		Style's Height.		Inclination of *Meridians*.	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
71	36	55	11	41	74	55
72	37	6	11	6	75	44
73	37	15	10	29	76	33
74	37	24	9	53	77	21
75	37	32	9	16	78	9
76	37	40	8	40	78	57
77	37	47	8	3	79	46
78	37	53	7	27	80	33
79	37	59	6	49	81	21
80	38	4	6	12	82	00
81	38	9	5	35	82	36
82	38	14	4	58	83	43
83	38	17	4	20	84	31
84	38	21	3	44	85	18
85	38	23	3	6	86	5
86	38	26	2	28	86	52
87	38	28	1	52	87	39
88	38	29	1	15	88	26
89	38	29	0	37	89	13
90	38	30	0	00	90	00

THE

THE

Explanation and Uſe

Of the foregoing

TABLE.

Laſtly, The Table of the *Three Requiſites in Dialling* is explained in Chap. XI, where I have ſhewn how to find the *Subſtyle's Diſtance* from the *Meridian*, the *Style's height*, and the *Inclination of Meridians* for *Latitude* 53 *Deg.* 22 *Min.* and the *Plane's Declination* 21 *Deg.* 10 *Min. Weſt*, which may ſerve as a *ſtanding Rule* for any other *Latitude* and *Declination* whatſoever.

TABLE

TABLE VI.

A TABLE ſhewing the *Sun's Altitude* every *Hour and Quarter* of the Day at his *Entrance* into the 12 *Signs* of the *Zodiack* for the *Latitude* of *London.*

N. B. *This Table is uſeful in drawing* Reflective Dials.

TABLE VI.

A TABLE shewing the *Sun's Altitude* every *Hour and Quarter* of the Day, at his Entrance into the 12 *Signs* of the *Zodiack* in the *Latitude* of *London* 51 *Deg.* 32 *Min. North.*

Hours	♋		♊ ♌		♉ ♍		♈ ♎		♓ ♏		♒ ♐		♑
	M.	D.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D. M.
XII	61	57	58	39	49	58	38	28	26	58	18	17	14 59
1	61	48	58	34	49	52	38	22	26	52	18	10	14 52
2	61	22	58	8	49	32	38	4	26	37	17	56	14 39
3	60	39	57	27	48	57	37	36	26	12	17	34	14 18
I XI	59	42	56	33	48	10	36	56	25	37	17	3	13 48
1	58	29	55	25	47	11	36	5	24	53	16	24	13 9
2	57	4	54	6	46	1	35	4	24	1	15	36	12 23
3	55	29	52	34	44	40	33	58	22	59	14	19	11 29
II X	53	45	50	55	43	11	32	36	21	49	13	36	10 28
1	51	53	49	7	41	52	31	8	20	31	12	24	9 19
2	49	54	47	12	39	47	29	34	19	6	11	6	8 3
3	47	51	45	13	37	57	27	53	17	36	9	42	6 41
III IX	15	42	43	7	35	59	26	5	15	57	8	11	5 13
1	43	31	40	58	33	57	24	12	14	13	6	34	3 39
2	41	15	38	45	31	49	22	25	12	23	4	51	1 59
3	38	59	36	30	29	40	20	13	10	30	3	5	0 15
IV VIII	36	40	34	14	27	28	18	7	8	32	1	13	
1	34	23	31	56	25	13	15	58	6	31			
2	32	4	29	37	22	56	13	46	4	25			
3	29	43	27	16	20	37	11	32	2	16			
V VII	27	23	24	56	18	18	9	17	0	5			
1	25	4	22	37	15	59	6	58					
2	22	46	20	17	13	39	4	39					
3	20	28	17	57	11	19	2	20					
VI VI	18	12	15	42	9	6							
1	15	58	14	0	6	44							
2	13	46	11	13	4	22							
3	11	37	9	1	2	8							
VII V	9	30	6	52									
1	7	25	4	46									
2	5	24	2	42									
3	3	27	0	43									
VIII IV	1	34											

THE Explanation and Uſe Of the foregoing TABLE.

THIS Table ſhews the *Sun's Height* or *Altitude* at every *Hour and Quarter* of the Day, for *the Latitude* of *London*, and is uſeful in drawing *Hour Lines* upon your *Quadrant* *, and *alſo* for drawing the *Hour Lines* upon the Cieling of your Room in the *Reflective Dial*, and by your *Quadrant* you may find the *Sun's Altitude* at *any Time* of the Day wherever you are, by holding your *Quadrant* up and looking through the *Sights* at the *Sun*, and the *Thread* will cut the *Limb*, or *Arch* of the *Quadrant* in the *Degrees* of the *Sun's height* at that *Time* and *Place*; the *Minutes* muſt be *gueſſed at*, becauſe every *Degree* being ſuppoſed to be *divided* into 60 *equal Parts* called *Minutes*, and thoſe *Diviſions* called *Degrees* being *ſmall*, it is impoſſible they ſhould *actually* be divided into *Minutes* or 60 *equal Parts*, ſo that if the *Thread* cuts a *Quarter* of a *Degree*, then call the *Minutes* 15, if it cut *one Third* of a *Degree*, call them 20 *Minutes*, if a *half* 30, if *two Thirds* 40, if *three Fourths*, then the *Minutes* are 45, *&c.* and thus you may take the Height of the *Moon* and *Stars*. And by this means may you make the like Table for your *own* or any other *Latitude*.

CHAP.

* For further Satisfaction herein you may ſee my *Syſtem of Aſtronomy*, Vol. I. page 111.

CHAP. XX.

CHAP. XX.

Shewing the USE *of the* Scales *in* Plate II.

IN *Prob.* 9, 10, 11 and 12, I have ſhewn how to make the *Scales* in *Plate* II, and in *Chap.* XVI. *Page* 72, I have ſhewn *how to uſe* the Line of Chords, in meaſuring of any *right lined Angles*; The *Lines of Hours* and *Latitudes* are general for pricking down all Dials *with Centers*, as the *Horizontal*, *South Direct*, &c. as for

Of the Lines of Hours *and of the* Lines of Latitude.

Example.

Let it be required to draw a Dial upon an *Horizontal Plane* for the *Latitude* of *London* 51 *Deg.* 32 *Min.*

See Plate 11. *Fig.* 1.

For the Hour Lines *and* Style's height.

Draw C D for the *Meridian*, or *Hour Line of* 12, and croſs it at *right Angles* in C, with A B; then from the *Scale of Latitudes*, ſet off C A and C B *each* equal to 51 *Deg.* 32 *Min.* for the *Style's height*. Then take the *whole* Scale of Six Hours in your Com-

For the Hour Lines.

CHAP. XX.

paſſes, and ſet it from A to D; draw A D and B D: *Divide* the Lines A D and B D as the *Scale of Six Hours* is divided, and *thro'* thoſe *Diviſions* draw Lines to the *Center* C, which ſhall be the true *Hour Lines* ſought, to which put their *proper Figures* as you ſee done in the Dial.

This is a very ready and eaſy way to deſcribe the *Hour Lines* on any Plane.

For the Style.

Take C A in your Compaſſes, and ſet from D to E, draw C E for the *Style*, which muſt ſtand *perpendicular* upon the Line C D, and ſo is your Dial compleatly finiſhed.

Ever remember to make an Allowance for the *Thickneſs* of the *Style* in all Dials, as I have cautioned you before.

An Example.

Of a North *and* South Direct *Dial for* Penzance *in* Cornwall.

Of a *North* and *South* Erect Direct Dial for *Penzance* in *Cornwall*, whoſe *Latitude* is 50 *Deg.* 8 *Min.* N.

See Plate 11. *Fig.* 2.

This Dial is made the very ſame Way as I have juſt now ſhewn in the *Horizontal Dial*, only inſtead of taking the *Latitude* from the *Scale of Latitudes*, you muſt here

in this Dial take the *Complement of the Latitude of the Place*, viz. 39 *Deg.* 52 *Min.* and ſet it from C to A, and B, which is alſo the *Style's height*. CHAP. XX.

The Style's height.

For the Hour Lines *of the* South *and* North *Dials.*

Take the *Scale of Six Hours*, and *ſet* from A to D, draw A D and B D, then take in your Compaſſes *each* Hour *ſeverally* from the *Scale of Six Hours*, and mark them off in the Lines A D and B D; *thro' thoſe Points*, draw Lines from the *Center* C, and they ſhall be the *true Hour Lines* required.

For the Style.

Set A C from D to E, and continue it *beyond the Center* C, which ſhall be the *Styles* for the *North* and *South* Dial, as you ſee done in the Dials.

Of the Scale of Inclinations.

By *the Scale of Inclinations* is known in *erect Decliners*, where the *Subſtylar Line* will fall; which muſt always be on the *contrary Side*, the *Meridian Line* or *Hour Line of* 12; that is, if the Plane declines *Weſtward* the *Subſtylar Line* muſt ſtand on the *Eaſt ſide*, but if the Plane decline *Eaſtward*, then the *Subſtylar Line* muſt be placed on the *Weſt ſide* the *Meridian*: and if *the In-*

CHAP. XX.

clination of Meridians be *less* than 15 *Deg.* the *Substylar Line* will fall *between* 11 and 12, or between 12 and one a-clock, according to which *Point of the Heavens* the Plane *declines*: if the *Inclinations of Meridians* be more than 15 *Deg.* but less than 30 the *Substylar Line* will fall between the Hours of *one* and *two*, &c. *Some Dialists* put the *Difference of Meridians* of *several Places*, as *Jerusalem*, *Madrid*, &c. upon the Dial to shew the Time of the Day at *those* Places, as well as the Time *where you are*; but this is needless; for if at any Time you would know what a-clock it is at any Place in the known World, when it is such a Time at *London*, only turn to the Table of the *Latitude and Longitude* of Places at the End of this Treatise, and there see what the *Difference of Meridians* is; and if the Place be to the *East* of *London*, add *the Difference of Meridians in Time* to the Time at *London*, which gives the Time at *that* Place; but if it lie to the *West*, substracting the *Difference of Meridians* in Time from the Time at *London* gives you the Time of the Day at *that* Place

The Difference of Meridians of several Places unnecessarily *put upon Dials.*

How to find what a-clock in any part of the World.

Example.

An Example of the Hours *at* London *and* Constantinople.

Suppose it is 10 a-clock in the *Forenoon* at *London*, what Time is it *then* at *Constantinople*, and also at *Port Royal* in *Jamaica*?

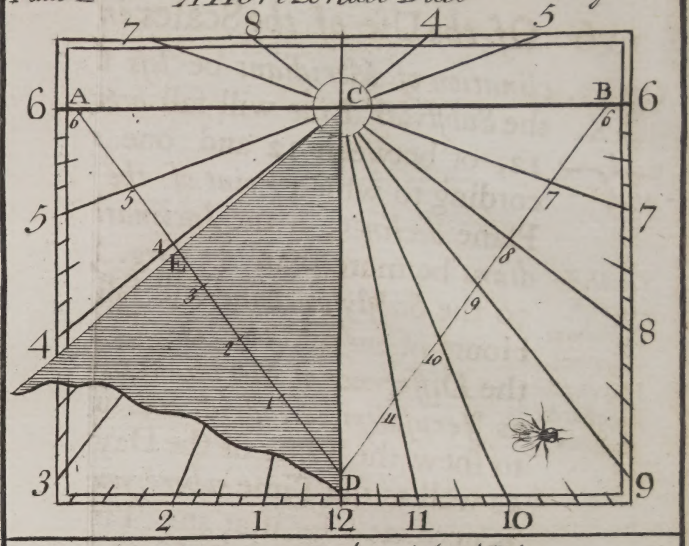
Given

These Dials are made by Scales in Plate 2

Plate II

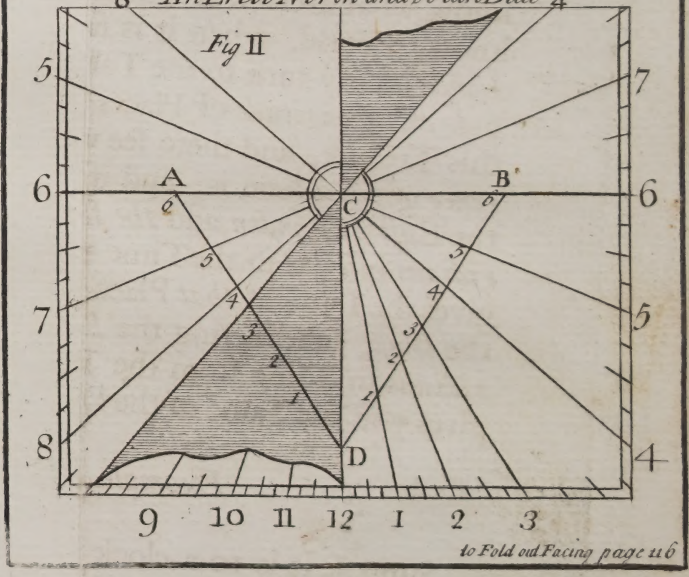
A Horizontal Dial

Fig I



An Erect North and South Dial

Fig II



to Fold out Facing page 116

	H.	*M.*	CHAP.
Given Time at *London* is ——	10	00	XX.
Conſtantinople to the *Eaſt* (add) —	1	59	
Time at *Conſtantinople* ——	11	59	

That is 59 *Min. paſt* Eleven in the *Forenoon.*

Again.

	H.	*M.*	
Given Time at *London* is ——	10	00	*Of the* Hours *at* London *and* Port Royal.
Port Royal to the *Weſt* (ſubſtract)	5	4	
Time at *Port Royal* in the *Morning*	4	56	

The like of any other Place in the *Catalogue.*

The Uſe *of the* TRIGON.

See the Figure on Page 13.

You are to take notice, that the *Parallels of the Signs*, the *Daily Arches*, the *Circles of Altitude*, and *all other Circles* relating to the *Courſe of the Sun*, when they are deſcribed upon any *Sun Dial*, are not ſhadowed out by the *whole Style*, or *Axis of the Dial* as *the Hours* are, but by ſome *one Point* in the ſame *Style* or *Axis*; as by a *Knob*, *Button*, or *Notch*, filed in the *Style* of the Dial; or by a *Hole in a Glaſs Window*

CHAP. XX.

for *projected Dials*; or by a *Piece of Looking-glass* for *reflected Dials*; in all which Cases the *Trigon* at C is to be applied, so that the *Line* thereof marked A B, must lie upon the *Style* of the Dial, or *parallel* to the Axis of the World, if it be an *Hole in a Window*, or *Piece of Looking-glass:* And now, the *Trigon* being thus placed with the *Equinoctial* C D ♈ *perpendicular to the Style*, the *Center* being always fixed upon the *Button* or *Notch*, or *Knob*, so that you may turn it about the *Axis*, as occasion shall require.

For the Equinoctial.

Now suppose you would insert the *Equinoctial* into any Dial, (for *one Rule serves for all Planes.) First*, put a *Thread* through the *little Hole* marked with ● at ♈ and ♎, tying a Knot on the Thread that it slips not through the *Hole* in the *Trigon*; then put the *Center* C to the *Knob* in the *Style*, and the *Side* A B to *the Style itself:* This done, extend the *Thread* over the Line C D ♈ till it touch the *Dial Plane*; that Point *of touching* shall be *one* Point through which the *Equinoctial* is to be drawn upon the Plane: Then turning the *Trigon about*, still keeping the Line A B *parallel to the Style*, extend the *Thread* till it touch the Dial Plane in some *other Point*, and that shall be *another*

ther Point, through which the *Equinoctial* is to be drawn upon the Dial. CHAP. XX.

And if your Dial be all but *one plain Superficies*, *two Points* will be ſufficient to draw the *Equinoctial* by, it being a *great Circle* of the *Sphere*, and conſequently a *right Line* upon all *plain Superficies*; but

If the Dial conſiſt of *more than one* Plane, then muſt you in the ſame manner as *before*, find *two Points at leaſt* upon *each Superficies*; which you may eaſily and ſpeedily do by turning the *Trigon* about the *Style*, and keeping the Side A B *parallel* thereto, extending the *Thread* over the Line C D ♈ till it touch the Plane.

For the Tropick of Cancer.

In like manner if you would inſert the *Tropick of Cancer* into your Dial, you muſt put the Thread in *the Hole* at ♋, and then apply the *Center* C to the *Knob* in the *Style* keeping the *Side* A B *parallel to the Style* (as before) extend the Thread over the Line C ♋ till it touch the Plane, and that Point of touch muſt be *one Point* through which the *Tropick* of *Cancer* muſt paſs.

Again move the *Trigon* in the *ſame Poſition*, upon the *Style of the Dial* as occaſion requires; extend the Thread over the *Tropick* C ♋ till it touch the Plane, and that ſhall be *another Point* through which the

CHAP. XX.

Tropick muſt be drawn, and in this manner may you find as many Points upon the Plane as you pleaſe, and *the more the better*, for *theſe Parallels* will not be *ſtreight Lines*, as the *Equinoctial Line* was, but *conick* or *carved Lines*, *through* which Points a Line *being traced*, with an *even hand*, ſhall be the *Tropick of Cancer* upon your Dial Plane.

For the Tropick of Capricorn.

And in this manner may the *Tropick of Capricorn*, and all the *Parallels* of the *other Signs* (or any other *Parallel* of the *Sun*'s *Declination)* be drawn on your Dials, if firſt you put the *Thread* through the *reſpective Hole*, and apply the *Trigon* to the *Style*, and extend the Thread over the *Parallel of Declination* till it touch the Plane; *and thus* you may find as many Points as you pleaſe, thro' which to draw your *Parallels*, and this may ſuffice for the Inſcription of the *Parallels* of the *Signs of the Zodiack*.

Of the Parallels *of the* length of Days.

And if you would inſert the *Parallels* for the *length of the Day*, they are to be done in the ſame manner, if inſtead of the *Declinations for the Signs* you put into your *Trigon* the *Parallels* for the *length of the Days* you intend to inſert into your Dial.

N. B. In Page 114 I have given a caution to all *Dialiſts*, that they be careful *always to make Allowance* for the *Thickneſs*

ness of the *Style*, otherwise the Dial will err from the Truth. CHAP. XXI.

CHAP. XXI.

A Review of the Equinoctial *and* Direct East *and* West *Dials.*

Of the Equinoctial Dial, *after what is said concerning it in* CHAP. III.

Some Properties of this Dial.

IF to this you add a *Semicircle* to represent *one half* of the *Meridian*, and graduate the *Meridian* unto 180 *Deg.* by two Ninety's, and set it in a Notch over a Box and Needle well touched with the Load-stone, it will shew you the Hour of the Day wherever you be, as also the *Variation* of the Needle itself in that Place; for when you have set it to shew the *Hour*, if the *Needle* then lie *parallel* with the *Semicircle*, representing *one half* of the *Meridian*, it has then no Variation, but if it lies athwart with *the Meridian*, the *Angle* that it makes either to the *East* or *West* is the *Variation* of the Needle in that Place.

Of the Universality of this Dial.

It shews the Variation of the Needle.

What Hour Lines *may be omitted.*

N. B. It matters not whether you put any more *Hour Lines* upon the Dial than are

CHAP. XXI.

are *useful in the Latitude where you are*; as for instance at *London* you may omit the Hours *after eight at Night till four in the Morning*.

How naturally the Hour Lines *of all Dials are drawn from the* Equinoctial *Dial.*

How naturally the *Hour Lines* may be drawn upon any Plane from the *Equinoctial Dial*, I shall here shew. Fix your *Style* to your Dial Plane *in its right Position* by help of your *Quadrant*, *i. e.* by applying the Edge thereof to the *Style*, and then the String cutting the Limb thereof in the Degrees of the *Latitude* of your Plane, because the *Top* of the Style is *parallel* to the *Earth's Axis*; and be careful also that it stand at *right Angles* to the + *Substylar Line*, whatever Dial it be; then cut a slit quite thro' the *Equinoctial Dial* from the *North edge* to the *Center* along the 12 *a-clock Line* just so wide as to receive your *Style*; put this slit upon the Style of your Dial, so that the *Equinoctial Dial* may stand at *right Angles* thereto, for then doth it lie parallel to the Plane of the *Equinoctial* itself: From that Point where the *Equinoctial Dial* toucheth the Style, let fall a perpendicular upon the *Substylar Line*, this I call the *perpendicular height* of the Style; take this in your Compasses, and set one Foot in the *Substylar Line* where the *perpendicular height* of the Style touched it, and sweep a *Circle*; to this Circle draw a *Tangent Line* at *right Angles* to the *Substylar Line*;

Line; *Lastly*, Put a Thread in the *Center* of the *Equinoctial Dial* (allowing for the Thickness of the Style) and stretch it over the *Hour Lines*, and where the Thread toucheth the *Tangent Line* upon your Plane make Marks; and Lines drawn from the Center of your Dial to those Marks in the *Tangent Line* are the true *Hour Lines* upon your Dial: and this is a plain and ready way of drawing *Hour Lines* upon all Sorts of Planes. CHAP. XXI.

A REVIEW *of the direct* West Dial *after what is said concerning it in* CHAP. VII, VIII.

Some Curiosities concerning the Direct East *and* West Dials.

This Dial as well as the East Dial is universal, which I thus explain; procure a Plate of Brass of what Size you please, and about the Thickness of a Shilling well polished on both Sides, on which draw an *East* Dial on *one Side* and a *West* Dial *on the other*, so that the Center of the Circle P H D S, on *one Side* may exactly answer the Center of the Circle on the *other Side*; let a Circle circumscribe your Dials, and the upper Quadrant divided into 90 equal Parts or Degrees; let there be a Ring in a swivel to screw to the *Zenith* of the Place wherever you be, after the manner of a Ring Dial; then hanging it on your Finger, placing its Plane parallel to the *Meridian* of the Place (which may

CHAP. XXI.

may be done by help of a Magnetic Needle) it will shew you the true Hour of the Day, except it be exactly 12 a-clock, and then neither the *East* or *West* Side will shew the Hour, for the Shadow of the Styles do then fall off both the Planes.

These Things I mention as Curiosities, shewing how by keeping the Axis of your Dial parallel with the Axis of the World, the Dial by that means is universal, for under the *Arctic Pole* the Hour Line will be *perpendicular* to the Horizon, and under the *Equinoctial* they will become *parallel*, or lie in the Plane of that great Circle. But if under the *Equinoctial* you lay the Dial flat down, so that the Circle P H D S may represent the Horizon of that Place, and placing 12 where 6 now stands, one where 5 is, *&c.* and 11 where 7 is, and 10 instead of 8, *&c.* to 6; this Dial will then represent a *Polar* or *Equinoctial* Dial, which ever you please to call it.

CHAP.

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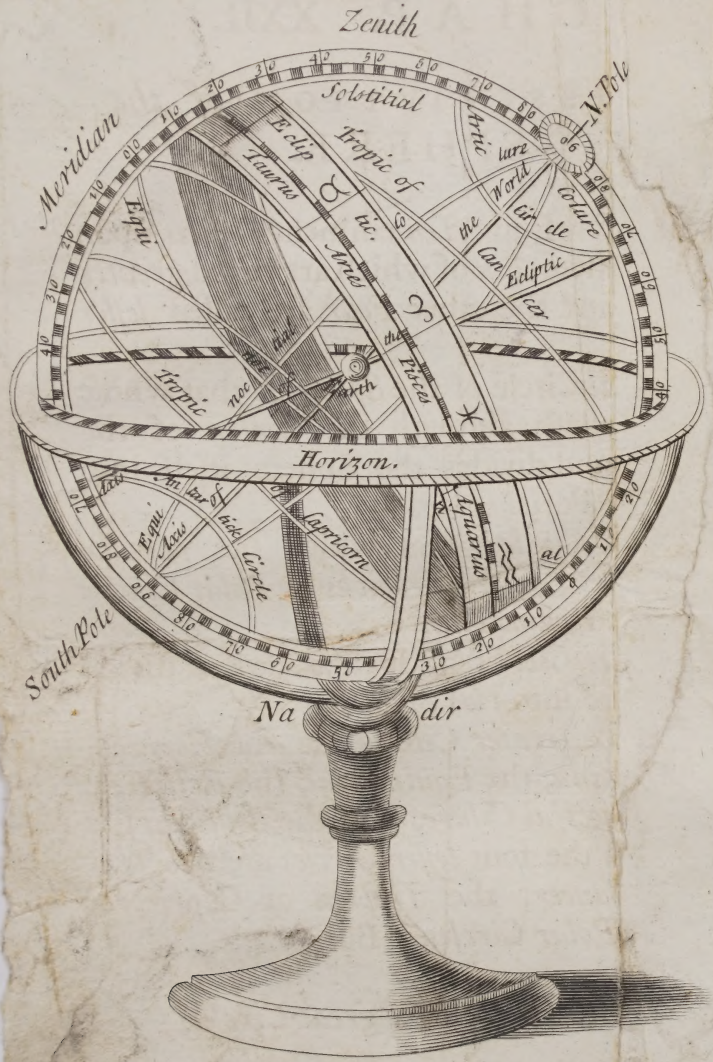

The Sphere

CHAP. XXII.

CHAP. XXII.

A DESCRIPTION *of the* SPHERE.

The Division of the Sphere.

THERE are *Ten* eminent *Circles* upon Sphere; *Six* of which are called *greater Circles*, and the other *Four* are called *leſſer Circles*.

A great Circle *what.*

A *great* Circle of the *Sphere* is that whoſe *Plane* paſſeth through the *Center* of the Sphere, and divides the Sphere itſelf into *two equal* Parts.

A leſſer Circle *what.*

A *leſſer Circle* is that which lies *parallel* to a *greater*, as the *Tropicks* or *Polar Circles* do to the *Equinoctial*.

Or *leſſer Circles* are ſuch as do *not* divide the Sphere into *two equal* Parts.

The Names *of the Six* greater *and four* leſſer Circles *of the* Sphere.

The ſix *greater* Circles are the *Horizon*, the *Meridian*, the *Equinoctial*, the *Ecliptick*, the *Equinoctial Colure*, and the *Solſtitial Colure*, and the four *leſſer Circles* are the *Tropick* of *Cancer*, the *Tropick* of *Capricorn*, and the *Polar Circles*. But,

Firſt, *Of the* SIX *great Circles.*

The Horizon.

1. The *Horizon* is that *Circle* whereon the *Earth* and *Sky* ſeem to meet, and therefore when the *Sun*, *Moon*, and *Stars* come to

CHAP. XXII.

to the *East* thereof they are said to *Rise*, and when they come to the *West* thereof they are said to *Set*.

The Meridian.

2. The *Meridian* is that *Circle* which is exactly in *the middle* between the *East* and *West*, and always cuts the true *North* and *South* Points of the *Horizon*; its *Use* is to show the Times of *Mid-day* and *Mid-night*, for when the *Sun* comes to the *South Point* of *this* Circle which is *above* the *Horizon*, it is *Noon*, and when to that Point of the Circle which is *under* the *Horizon*, then it is *Midnight*, and *that Point* in the *Meridian* which is exactly *over your Head*, is called the *Zenith*, and that *under your Feet*, the *Nadir*.

The Equinoctial.

3. The *Equinoctial* Circle is always distant from you as much as is *the Latitude of the Place* you are in, and is also *equal* to the *Height of the Pole* above your *Horizon*; its *Use* is to determine the Time of the *Day* or *Night*; for every 15 *Deg.* thereof is *equal* to *one Hour* in *Time*, and it always cuts the true *East* and *West* Points of the *Horizon*.

The Ecliptick.

4. The *Ecliptick* is that Circle in which the *Sun* is said to move, and *this Circle* cuts the *Equinoctial* in the *beginning* of *Aries* and *Libra*, making an *Angle* therewith of 23 *Deg.* 29 *Min.* which *Angle* is equal to the *Sun's greatest Declination:* It is divided into *twelve* equal Parts, called *Signs*, and *characters* as in the *Figure* with ♈, ♉, ♊, *&c.* and

and every *Sign* is divided into *thirty* equal Parts called *Degrees*; so that *This*, and *every great Circle* of the *Sphere* contains 360 *Deg.* CHAP. XXII.

N. B. In or *near* this *Circle* the *Eclipse* of the *Sun* and *Moon* are always found from whence it takes its Name.

5. The *Equinoctial Colure* is a Circle that cuts the *Equinoctial* at *right Angles* in the *beginning* of *Aries* and *Libra*, and passes *thro'* the *Poles* of the World: This Circle determines the *beginning* of the *Spring*, and *fall of the Leaf*, for when the *Sun* comes here (which is on the 10th of *March* and 12th of *September)* the *Days* and *Nights* are *equal.* *The* Equinoctial *Colure.*

6. The *Solstitial Colure* is a Circle that cuts the *Equinoctial Colure* at *right Angles* in the *Poles* of the World, and when *Cancer* is upon the *Meridian*, *this* Circle is also upon the *Meridian* (as you may see by the Sphere) when the *Sun* comes to this *Colure* (which is upon the 10th of *June* and the 10th of *December)* he determines the *longest* and *shortest Days* to all the Inhabitants on the *North Side* the Equinoctial. *The* Solstitial *Colure.*

N. B. The above *six Circles* cut the *World* into *two* equal Parts.

Secondly,

CHAP. XXII.

Secondly, *Of the* FOUR leſſer Circles *of the Sphere.*

Of the Four leſſer Circles.

The Tropick *of* Cancer.

1. The *Tropick of Cancer* is parallel to the *Equinoctial*, and diſtant from it 23 *Deg.* 29 *Min.* which is the *Sun's greateſt Declination Northward*; here the *Ecliptick* and the *Solſtitial Colure* meet in the very beginning of *Cancer*, making the *longeſt Day* to all the *Northern Inhabitants.*

The Tropick *of* Capricorn.

2. The *Tropick of Capricorn* is alſo parallel to the *Equinoctial*, but diſtant from it 23 *Deg.* 29 *Min.* towards the *South*, and is equal to the *Sun's greateſt Declination*; here the *Ecliptick* and *Solſtitial Colure* meet in the very beginning of the Sign *Capricorn*, making the *ſhorteſt Day* to all the *Northern Inhabitants.*

The Reaſon why theſe are called *leſſer* Circles is, becauſe they cut the *Sphere* (or World) into *two unequal* Parts.

The two Polar Circles.

LASTLY. The *two Polar Circles* are the ſame Diſtance from the *Poles*, that the *Tropicks are* from the *Equinoctial*, viz. 23 *Deg.* 29 *Min.* When the Sun enters *Cancer*, thoſe that live under the *Arctic Circle* ſee him in their *Horizon* at *Midnight*, and when the Sun enters *Capricorn*, thoſe that live under the *Antarctic Circle* ſee the Sun in their *Horizon* at *Midnight.*

The

CHAP. XXII.

The *Earth's Axis* is a Line ſuppoſed to paſs from *Pole to Pole*, and *through* the *Earth's Center*; and *note*, it always repreſents the *Top*, or uppermoſt Part of the *Style* in *all Dials:* and makes *an Angle* with the *Horizon* equal to the *Latitude* of your Habitation: and it always cuts the *Equinoctial* at *right Angles*, and the *Equinoctial* makes an *Angle* with the *Horizon* equal to *the Complement of the Latitude of the Place* where you live.

The Earth's *Axis.*

The *Earth* is fixed upon its *Axis* in the *middle* of the *Sphere* (or World) and in *Dialling* it is reckoned no more than a *Point*, becauſe it is at ſo vaſt a Diſtance from the *Sun.*

The Earth.

N. B. The *Axis* of the *Ecliptick* is noted in the *Sphere*, but it is of no manner of Uſe in Dialling.

The Axis of the Ecliptick.

CHAP. XXIII.

Motto's *for Dials, with their Meaning in* Engliſh.

1. ALIIS inſerviendo conſumor.
   My Loſs is your Gain.
2. Ars longa Vita brevis.
   I die to-day and live to-morrow.
3. Avaritia Hodie dominatur.
   You covet to-morrow.
4. Aut Cæſar aut Nihil.
   I ſhine or ſhroud.
5. *See, and be gone about your Buſineſs.*
6. Bulla eſt Vita humana.
   Life's a Bubble.
7. *Conſume not thy Time in Idleneſs.*
8. Deus adeſt laborantibus.
   Heaven favours the diligent.
9. Diſce dies numerare tuos.
   Learn to value your Time.
10. Diſce bene vivere & mori.
    Shine and Set.
11. Dies diem trudit.
    A Day kicks me down.
12. Dum ſpectas fugio.
    Unſight, unſeen.

13 * En supra Vita fugax,
‡ En infra certa Mors.
A Life on flight's soon out of sight.

14 Ex hoc Momento pendet Æternitas.
Now or never.

15 Festina Lente.
Mind my Movements.

16 Fortuna urbes ampliſſimas evertit.
No Exemption from my Influence.

17 Fugio Fuge.
Be gone about your Buſineſs.
I ſtay for no Man.

18 * Hinc vivere diſce,
† Illinc diſce Mori.
Riſing portends Setting.

19 Homo quaſi Umbra.
Man is Shade of a Shadow.

20 Hora fugit rapide lethumq; invadit inermes.
The Hours glide ſwiftly, and the unguarded are eaſily ſurprized.

21 Hora pars Vitæ.
Every Hour ſhortens Life.

22 Ita Vita.
Such is Life's half Circle.

23 Labor ipſe voluptas.
My Pain is your Pleaſure.

24 Lex Dei Lux Diei.
The Law of God is broad Day-light.

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* At the *Top*
‡ At the *Bottom* } of *one* Face of a Dial on St *Mary Overy*'s Church, *Southwark*, which hangs over the *Burial Ground*.

* At the *Top*
† At the *Bottom* } of *another* Face of the Dial on St *Mary Overy*'s Church, *Southwark*, which hangs over the *Burial Ground*.

CHAP. XXIII

25 †*Let your Light ſo ſhine that Men may ſee your good Works.*

26 Lente fuſcipe cito perfice.
Set out at Leiſure, proceed with haſte.

27 Mora trahit periculum.
Delay drags Danger.

28 Nemo ſine crimine vivit.
The brighteſt Day has its ſhades.

29 Nil dat quod non habet.
Out of nothing comes nothing.

30 Non ſemper erunt Saturnalia.
Take Time by the Forelock.

31 Non nobis nati ſumus.
We are not made for our ſelves.

32 Non ſine lumine.
We ſhine.

33 Noſce teipſum.
Look into thy ſelf.

34 Nulla dies ſine linea.
Every Day has its bounds.

35 Omnem crede diem tibi diluxiſſe ſupremum.
Believe every Day to be thy laſt.

36 Omnia falce metit tempus.
The ſcythe of Time carries a keen Edge.

37 Pereunt & imputantur.
The Hours vaniſh, yet are on Record.

38 Pax optima rerum.
Light is the Parent of Peace.

39 Poſt voluptatem miſericordia.
* *Pleaſure is the Parent of Pain.*
Night treads upon the Heels of Day.

† In *Lincoln's* Inn, *London.*

* Upon a Dial at a *Lock*, or Hoſpital for thoſe who hav
the ſoul Diſeaſe.

40 Quali

40 Qualis vita, finis ita.
Praise a fair Day at Night.

41 Quod tibi fieri non vis, alteri ne feceris.
Do not render Evil for Good.

42 Qua redit nescitis horam.
Ye know not the Hour.

43 Quid celerius tempore?
What is swifter than Time?

44 Sic vita.
Life's Lot.

45 Sic transit gloria mundi.
So marches the god of Day.

46 Sine lumine inane.
Darkness precedes Day.

47 Sic præterit Ætas.
Life is winged.

48 Tempus ad lucem ducit veritatem.
Time brings Truth to Light.

49 Tempus obit, mors venit.
Time dies, Death reigns.

50 Tempus fugit.
Time hastes.

51 Tempus vitæ monitor.
Time is Life's Remembrancer.

52 Tenere non potes nec perdere.
You cannot keep it, nor lose it.

53 Umbra Dei.
The Workmanship of the great Architect.

54 Ut umbra sic vita.
Shade is Life's Pattern.

55 Venio ut fur.
I steal upon you.

CHAP. XXIII

56 Vigilate & orate, tempus fugit.
Watch and Pray, Time haſtes away.

57 Via vitæ.
Life's Road.

58 Vita noſtra eſt inſtar Comœdiæ.
Life often changes Scenes.

59 Veritas temporis filia.
Time the Father of Truth.

60 * Welcome Chapmen.

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* On a Dial in a Market-place.

CHAP. XXIV.

A new Table of the Elevation of the Pole, *and* Difference of Meridians *from* London.

A *New* and *Correct* Alphabetical Table of the moſt eminent *Cities*, *Towns*, &c. in the World; * ſhewing at each Place *the Elevation of the Pole*, and the *Difference of their Meridian* from *London*.

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* *N. B.* The Table of the principal Cities and Towns in *England*, *Scotland*, *Ireland* and *Wales* is on Page (16, &c.)

☞ The *Elevation of the Pole* signifies the same Thing as *the Latitude of the Place*, and *the Difference of the Meridian*, the same as *the Longitude of the Place*. CHAP. XXIV.

Note,

D, H, M } signifies { *Degrees*, *Hours*, *Minutes* || E, W, N, S } signifies { East, West } *Longitude*. { North, South } *Latitude*.

An Explanation *of the following Table.*

The *Names* of the Places ſtand in an *Alphabetical Order*, and thoſe *Names* are always followed by *One* or *Two* more in the ſame Line or Article. Where there is but *One* Name following *that* of the *Place*, it ſignifies what *Kingdom* or *Part of the World* it is ſituated in; as *Athens*, Greece, ſignifies that *Athens* is in Greece: But where there are *Two* Names following the Name of the *Place*, the *Firſt* ſignifies the *Province* or *Diviſion*, and the *Second* the *Kingdom* or Part of the World, as *Abbeville*, Picardy, France, ſignifies that *Abbeville* is in Picardy, which is a *Province* in France, and ſo of all the reſt.

CHAP. XXIV	A.	*Latit.* D. M	*Dif.Mer.* H.M
	Abbeville, Picardy, France	50 9 N	0 9 E
	Abo, Finland, Sweden	60 20 N	1 39 E
	Achin, Sumatra, East-Indies	4 40 N	6 13 E
	Acquin, Montferrat, Italy	44 13 N	0 41 E
	Adrianople, Turkey, Europe	43 18 N	1 50 E
	Agen, Guienne, France	44 13 N	0 2 E
	Agra, a Capital in the Mogul's Empire	29 0 N	5 38 E
	Agria, Hungary	48 2 N	1 12 E
	Aichſtat, Franconia, Germany	48 46 N	0 43 E
	Aix, Provence, France	43 4 N	0 23 E
	Aix la Chapelle, Weſtphalia, Germany	50 48 N	0 28 E
	Albert, Gaſcony, France	44 14 N	0 4 W
	Alby, Languedoc, France	43 43 N	0 8 E
	Alba Regalis, Hungary	47 23 N	1 8 E
	Alcala, New Caſtile, Spain	40 30 N	0 13 E
	Alcantara, Extremadura, Spain	9 15 N	0 23 W
	Alcaran, New Caſtile, Spain	39 0 N	0 7 W
	Alençon, Normandy, France	48 31 N	0 1 E
	Aleppo, Syria, Aſia	37 0 N	2 45 E
	Alexandria, Egypt, Africa	31 25 N	2 3 E
	Alexandretta, Syria, Aſia	37 10 N	2 31 E

Algiers,

	Latit. D. M	Dif.Mer. H.M
Algiers, Barbary, Africa.	36 20 N	0 9 E
Alicant, Valentia, Spain	37 45 N	0 1 E
Almeria, Granada, Spain	35 50 N	0 8 W
Amand, Bourbon, France	46 32 N	0 9 E
Amberg, Bavaria, Germany	49 26 N	0 52 E
Ambrun, ſee Embrun		
Amiens, Picardy, France	49 30 N	0 11 E
Amſterdam, Holland	52 29 N	0 20 E
Ancona, Italy	43 30 N	0 58 E
Angers, Orleans, France	47 27 N	0 4 E
Angouleſme, Orleans, France	45 25 N	0 2 W
Angiera, Milan, Italy	45 8 N	0 39 E
Annacy, Savoy, Italy	45 56 N	0 27 E
Antibe, Provence, France	43 15 N	0 33 E
Antwerp, Brabant	51 16 N	0 17 E
Antequera, Granada, Spain	36 40 N	0 16 W
Aouſte, Piedmont, Italy	45 40 N	0 30 E
Apenzel, Switzerland	46 57 N	0 43 E
Appenrade, Sleſwick, Denmark	55 26 N	0 42 E
Apte, Provence, France	43 50 N	0 24 E
Aquila, Naples, Italy	42 18 N	0 58 E
Aranda, Old Caſtile, Spain	41 20 N	0 12 W
Archangel, Ruſſia,	64 30 N	2 41 E
Ardres, Picardy, France	50 53 N	0 7 E
Arhuſen, Jutland, Denmark	56 32 N	0 45 E

CHAP. XXIV

	Latit. D. M	*Dif.Mer.* H. M
Arica, Peru, South America	18 50 S	4 59 W
Arles, Provence, France	43 15 N	0 19 E
Armentiers, Flanders	50 45 N	0 8 E
Asperosa, Romania, Turkey	40 50 N	1 43 E
Astracan, near the Caspian Sea, Muscovy	46 50 N	3 26 E
Asti, Piedmont, Italy	44 40 N	0 34 E
Astorgos, Leon, Spain	42 29 N	0 22 E
Athens, Greece	37 25 N	1 35 E
Avignon, Provence, France	43 15 N	0 19 E
Ausburg, Suabia, Germany	47 55 N	0 43 E
Autun, Burgundy, France	46 38 N	0 18 E
Aux, Gascony, France	43 50 N	0 5 E
Axiopoli, Bulgaria, Turkey	44 30 N	1 42 E
B.		
Babylon, Chaldea	34 30 N	3 14 E
Badajox, Extremadura, Spain	38 40 N	0 24 E
Baden, Suabia, Germany	48 38 N	0 32 E
Bagdat, Mesopotamia, Asia	33 0 N	3 2 E
Bagnialuc, Bosnia, Turkey	44 25 N	1 2 E
Bahus, Norway	58 14 N	0 52 E

	Latit. D. M	*Dif.Mer.* H. M
Balaguer, Catalonia, Spain	41 30 N	0 1 E
Balbaſtro, Arragon, Spain	41 46 N	0 1 W
Baldivia, Chili, South-America	40 0 S	5 12 W
Bamburg, Franconia, Germany	49 35 N	0 45 E
Barbadoes, Weſt-Indies	13 10 N	3 59 W
Barcelona, Catalonia, Spain	41 10 N	0 8 E
Barn, Naples, Italy	41 7 N	1 10 E
Barletta, Naples, Italy	41 20 N	1 8 E
Barleduc, Champagne, France	48 44 N	0 16 E
Baſil, Switzerland	47 34 N	0 32 E
Batavia, Java, Eaſt-Indies	6 05 S	7 6 E
Bayonne, Gaſcony, France	43 30 N	0 5 W
Beauvoies, France	49 20 N	0 6 E
Beaufort, Anjou, France	47 20 N	0 3 E
Beaujeau, Lionois, France	45 50 N	0 18 E
Belgrade, Servia	45 0 N	1 13 E
Belvedre, Naples, Italy	39 35 N	1 6 E
Benevente, Spain	41 55 N	0 21 W
Beneventum, Naples, Italy	41 13 N	1 2 E
Bengal, India	21 0 N	5 12 E

Bergamo,

CHAP. XXIV.	*Latit.* D. M	*Dif.Mer.* H.M
Bergamo, Italy	45 48 N	0 39 E
Bergen, Norway	60 0 N	0 22 E
Berlin, Upper Saxony, Germany	52 10 N	0 52 E
Bern, Switzerland,	47 0 N	0 31 E
Beſancon, Burgundy, France	47 10 N	0 25 E
Bielſk, Poland	52 50 N	1 37 E
Bielha, Ruſſia	55 36 N	2 13 E
Bilboa, Biſcay, Spain	43 10 N	0 9 E
Bilogrod, Budziack, Turkey	47 15 N	2 1 E
Biorneburgh, Finland, Sweden	62 12 N	1 30 E
Blois, Orleanois, France	47 30 N	0 5 E
Bologna or *Boulogne*, Italy	44 20 N	0 48 E
Bologne, Picardy, France	50 36 N	0 7 E
Bonn, Lower Rhine, Germany	50 30 N	0 30 E
Borkholm, Oeland, Sweden	57 10 N	1 15 E
Boſleduc, Brabant, Flanders	51 30 N	0 20 E
Boſton, New-England	42 10 N	4 28 W
Bourdeaux, Guienne, France	44 55 N	0 3 E
Boulogne, Modena, Italy	44 15 N	0 48 E
Bourges, Orleanois, France	46 54 N	0 10 E

Braga,

	Latit. D. M	*Dif.Mer.* H. M
Braga, Portugal	41 30 N	0 31 W
Brandenburgh, Upper Saxony, Germany	52 10 N	0 50 E
Breſt, Bretagne, France	48 34 N	0 18 E
Breda, Spaniſh Provinces	51 30 N	0 17 E
Bremen, Weſtphalia, Germany	53 0 N	0 35 E
Breſcia, Venice, Italy	45 36 N	0 42 E
Brieux, Bretagne, France	48 30 N	0 10 E
Breſhaw, Bohemia, Germany	51 5 N	1 6 E
Briancon, Dauphine, France	44 59 N	0 25 E
Brill, Holland	51 55 N	0 25 E
Brindiſi, Naples, Italy	40 48 N	1 13 E
Brixen, Auſtria, Germany	46 29 N	0 47 E
Brunſwick, Germany	51 55 N	0 46 E
Brugencia, Genoa, Italy	44 28 N	0 40 E
Bruges, Flanders	51 15 N	0 12 E
Bruſſels, Flanders	50 48 N	0 16 E
Buda, Lower Hungary	47 0 N	1 8 E
Budiſſen, Luſatia, Germany	50. 50 N	0 59 E
C.		
Cadiz, Andaluſia, Spain	36 5 N	0 23 W

Caen,

CHAP. XXIV

	Latit. D. M	*Dif.Mer.* H. M
Caen, Normandy, France	49 5 N	0 22 W
Cagliari, Sardinia, Mediterranean	39 10 N	0 38 E
Cahors, Guienne, France	44 26 N	0 6 E
Cairo, Egypt, Africa	30 10 N	2 6 E
Calais, France	51 0 N	0 8 E
Calmar, Sweden	56 55 N	1 9 E
Calahorra, Old Caſtile, Spain	41 52 N	0 8 W
Calecute, Eaſt-Indies	11 0 N	4 59 E
Cambray, France	50 10 N	0 13 E
Camin, Pomerania, Germany	53 54 N	1 1 E
Candia, in Candia-Iſland	34 55 N	1 39 E
Candia, Ceylon, Eaſt-Indies	7 30 N	5 22 E
Cape of Good Hope	34 25 S	1 6 E
Capra, Naples, Italy	41 8 N	1 1 E
Cartagena, Murcia, Spain	37 0 N	0 2 E
Carthage, Barbary, Africa	35 0 N	0 44 E
Caſal, Milan, Italy	45 5 N	0 34 E
Caſtillon, Guienne, France	44 32 N	0 7 E
Caſchaw, Hungary	48 30 N	1 13 E
Catanea, Sicily	37 20 N	1 1 E
Cattaro, Dalmatia	41 50 N	1 10 E

	Latit. D. M	*Dif.Mer.* H. M
Caudebeck, Normandy, France	49 36 N	0 2 E
Ceva, Piedmont, Italy	43 56 N	0 51 E
Ceuta, Africa	35 50 N	0 23 W
Charles Town in Carolina	32 30 N	5 24 W
Chalons, Champagne, France	48 50 N	0 19 E
Chambery, Savoy, Italy	45 38 N	0 24 E
Chimera, Epirus, Turkey	39 25 N	1 12 E
Chriſtianſtad, Gothland, Sweden	56 35 N	0 58 E
Clauſenburgh, Tranſylvania	47 20 N	1 24 E
Clermont, Lionois, France	45 40 N	0 13 E
Cleves, Weſtphalia, Germany	51 40 N	0 25 E
Coblentz, Lower Rhine, Germany	50 0 N	0 10 E
Cochin, Malabar, Aſia	10 0 N	5 1 E
Cochin China, E. Indies, Aſia	13 0 N	7 8 E
Coimbra, Biera, Portugal .	39 50 N	0 31 W
Cologne, Germany	50 40 N	0 29 E
Compoſtella, Gallicia, Spain	42 45 N	0 33 W

Conſtance,

Chap. XXIV		*Latit.* D.	M		*Dif.Mer.* H.	M	
	Conſtance, Suabia, Germ.	47	20	N	0	39	E
	Conſtantinople, Romania, Turkey	41	6	N	1	59	E
	Conza, Naples, Italy	40	45	N	1	4	E
	Conteſſa, Macedon. Tur.	40	55	N	1	38	E
	Copenhagen, Zeland, Denmark	55	40	N	0	50	E
	Coria, Extremadura, Sp.	39	20	N	0	22	W
	Corinth, Morea, Turkey	38	0	N	1	30	E
	Coſmopoli, on the Iſland Elba, Italy	42	30	N	0	44	E
	Coſenza, Naples, Italy	39	15	N	1	7	E
	Coſſana, Naples, Italy	40	12	N	1	8	E
	Coutance, Normand. Fr.	49	10	N	0	7	W
	Cracow, Poland	50	15	N	1	23	E
	Cremona, Milan, Italy	45	10	N	0	42	E
	Cuſco, Peru, S. America	12	20	S	4	48	W
	Cyprus-Iſland, Levant	35	0	N	2	16	E
	D.						
	Dantzick, Poland	54	25	N	1	18	E
	Dardanells, Turkey	40	0	N	1	52	E
	Darmſtat, Upper Rhine, Germany	49	30	N	0	37	E
	Delft, Holland	52	10	N	0	17	E
	Derbent, near the Caſpian Sea	42	0	N	3	20	E
	Deventer, United Prov.	51	56	N	0	24	E
	Deux Ponts, Upper Rh. Germany	49	10	N	0	29	E
	Die, Dauphine, France	44	45	N	0	22	E

Dijon,

	Latit.			Dif. Mer.			CHAP. XXIV.
	D.	M		H.	M		
Dijon, Bourgogne, Fr.	47	15	N	0	20	E	
Dole, Bourgogne, Fran.	46	50	N	0	23	E	
Dort, Low-Countries, Holland	51	45	N	0	18	E	
Doway, Flanders	50	12	N	0	14	E	
Dresden, Saxony, Germ.	51	6	N	0	55	E	
Drontheim, Norway	63	0	N	0	41	E	
Dunkirk, France	51	7	N	0	10	E	
Durazzo, Albania, Tur.	40	40	N	1	11	E	
Dusseldorp, Westph. Ger. E.	51	0	N	0	28	E	
Elbing, Poland	54	20	N	1	22	E	
Ellenera, Extremad. Sp.	37	45	N	0	19	W	
Elsinborg, Schonen, Sw.	56	0	N	0	53	E	
Embden, Westph. Germ.	53	10	N	0	29	E	
Embrun, Upper Dauphine, France	44	30	N	0	25	E	
Enchuysen, Holland	52	50	N	0	18	E	
Ephesus, Natolia, Asia	37	50	N	1	50	E	
Erfort, Saxony, Germ.	50	40	N	0	46	E	
Essek, Sclavonia	45	35	N	1	9	E	
Estella, Navarre, Spain	42	15	N	0	7	W	
Evora, Portugal	38	10	N	0	29	W	
Eureux, Normandy, Fr.	48	55	N	0	3	W	
Eysenach, Saxony, Germ. F.	50	40	N	0	43	E	
Ferrara, Italy	44	45	N	0	49	E	
Feurs, Lionois, France	45	24	N	0	15	E	
Fermo, Tuscany, Italy	43	10	N	0	59	E	
Fez, Barbary, Africa	33	15	N	0	24	W	

CHAP. XXIV.

	Latit. D. M	*Dif.Mer.* H. M
Finale, Genoa, Italy	44 10 N	0 34 E
Florence, Tuscany, Italy	43 40 N	0 47 E
St Flour or *Flerus*, Lionois, France	44 50 N	0 13 E
Fort St George, East Indies	13 0 N	5 20 E
Fontarabia, Biscay, Spain	43 0 N	0 7 W
Frankfort on the Oder, Germany	52 28 N	0 58 E
Frankfort on the Main, Germany	49 45 N	0 39 E
Freisingen, Bavaria, Germany	48 0 N	0 47 E
Freiburg, Suabia, Germ.	47 50 N	0 33 E
Frejuls, Provence, Fran.	43 30 N	0 28 E
Furnes, Flanders	51 15 N	0 11 E
Furstenburg, Suabia, Germany	47 15 N	0 37 E
G.		
Gallipoli, Romania, Turkey	40 55 N	1 53 E
Gelders, Gelderland	51 15 N	0 26 E
Geneva, Savoy, Italy	46 15 N	0 25 E
Genoa, Italy	44 25 N	0 37 E
Ghent, Flanders	51 6 N	0 14 E
Gibraltar, Andaluzia, Spain	35 30 N	0 19 E
Girona, Catalonia, Spain	41 45 N	0 13 E

	Latit. D. M	*Dif.Mer.* H.M
Giſors, Normandy, France	49 20 N	0 8 E
Glatz, Bohemia, Germ.	50 30 N	1 7 E
Gneſna, Poland	52 25 N	1 14 E
Goa, Eaſt Indies	15 22 N	4 58 E
Gombroon, Perſian Gulf	7 10 N	3 44 E
Gottenburgh, Sweden	57 30 N	0 48 E
Gran, Hungary	47 30 N	1 6 E
Granada, Granada, Spain	36 20 N	0 11 E
Gratz, Auſtria, Germ.	47 10 N	1 6 E
Graveling, Flanders	51 4 N	0 10 E
Grenoble, Dauphine, France	45 10 N	0 23 E
Grodno, Lithuania, Poland	53 25 N	1 40 E
Groeningen, Holland	53 5 N	0 23 E
Guadix, or *Gaudix*, Granada, Spain	36 40 N	0 9 E
Guadalaxara, New Caſtile, Spain	40 25 N	0 11 E
Gyulla, Hungary	46 30 N	1 16 E
H.		
Hague, Holland	52 10 N	0 16 E
Hall, Suabia, Germany	49 6 N	0 41 E
Hamburgh, Denmark	53 30 N	0 40 E
Hanaw, Upper Rhine, Germany	50 3 N	0 41 E
Hanover, Saxony, Germ.	52 16 N	0 36 E
Harlem, Holland	52 25 N	0 17 E

CHAP. XXIV

	Latit. D. M	*Dif.Mer.* H.M
Heidelburg, Lower Rh. Germany	49 12 N	0 35 E
Helmſtat, Saxony Germ.	51 52 N	0 49 E
Hermanſtat, Tranſylvania	46 45 N	1 28 E
Hildeſheim, Weſtphalia, Germany	51 45 N	0 41 E
Hoen-Zolern, Suabia, Germany	48 40 N	0 37 E
Hueſca, Saragoſa, Spain	41 45 N	0 1 W
Hulſt, Flanders	51 20 N	0 19 E
I.		
Jaca, Arragon, Spain	37 20 N	0 2 W
Jaen, Granada, Spain	37 0 N	0 11 W
Jaicza, Boſnia, Turkey	44 40 N	1 2 E
James Town, Virginia, North America	37 10 N	5 0 W
Jeruſalem, Paleſtine, Aſia	32 44 N	2 21 E
Ingolſtat, Bavaria, Germ.	48 32 N	0 52 E
Inſpruck, Auſtria, Germ.	47 40 N	0 59 E
Iſpahan, Antient Parthia, Perſia	33 0 N	3 33 E
Juanagorod, Ingria, Muſcovy	59 0 N	1 57 E
Judenburgh, Auſtria, Germany	47 20 N	1 1 E
Juliers, Weſtphalia, Germany	50 20 N	0 27 E
Ivrea, Piedmont, Italy	46 0 N	0 30 E

	Latit. D. M	*Dif.Mer.* H.M
K.		
Kaffa, Crim Tartary, Turkey	46 0 N	2 27 E
Kaminaick, Podolia, Poland	49 20 N	1 38 E
Kaniſcha, Hungary	46 35 N	1 0 E
Kargapol, Ruſſia	61 30 N	2 49 E
Kexholm, Finland, Swed.	61 20 N	2 4 E
Kimi, Lapland, Sweden	65 45 N	1 37 E
Kiow, Ukrain, Poland	50 30 N	2 10 E
Koningſburgh, Pruſſia, Poland	54 55 N	1 29 E
Konizeck or *Konioz*, Poland	54 15 N	1 15 E
L.		
Langrez, Champagne, France	47 55 N	0 22 E
Lanciano, Naples, Italy	41 50 N	1 0 E
Lancicio, Poland	52 15 N	1 19 E
Landſpergh, Poland	52 55 N	1 2 E
Landau, Suabia, Germ.	48 50 N	0 33 E
Laodicea, Natolia, Aſia	38 10 N	1 58 E
Laon, Lionoiſe, France	49 30 N	0 15 E
Lariſſa, Theſſaly, Turkey in Europe	39 30 N	1 29 E
Larta, Epirus, Greece, now Turkey	39 0 N	1 17 E
Lauback, Auſtria, Germ.	46 25 N	0 59 E
Lawenbergh, Saxony, Germany	53 20 N	0 43 E

CHAP. XXIV.	*Latit.* D. M	*Dif.Mer.* H.M
Legorn or *Leghorn*, Tuſcany, Italy	43 40 N	0 45 E
Lemburgh, Poland	49 50 N	1 41 E
Leon, Aſturia, Spain	42 34 N	0 20 W
Leopoldſtat, Hungary	48 45 N	1 15 E
Lepanto, Achaia, Turky	38 30 N	1 23 E
Lerida, Catalonia, Spain	41 15 N	0 3 E
Lewardin, Weſt Frieſland, Holland	53 0 N	0 26 E
Leyden, Holland	52 10 N	0 14 E
Leypſick, Germany	50 50 N	0 51 E
Leige, Spaniſh Provinces	50 25 N	0 22 E
Lima, Peru, S. America	11 30 S	5 15 W
Limoges, Guienne, Fran.	45 40 N	0 6 E
Limburgh, Spain	50 20 N	0 25 E
Lingen, Weſtphalia, Germany	52 25 N	0 31 E
Lintz, Auſtria, Germ.	48 10 N	0 58 E
Lip or *Lippa*, Tranſylvania	45 50 N	1 15 E
Liſle, Flanders	50 40 N	0 11 E
Liſbon, Portugal	38 45 N	0 33 W
Livorn, ſee *Leghorn*		
Lodi, Milan, Italy	45 20 N	0 40 E
Logronna, Old Caſtile, Spain	42 10 N	0 9 E
Lombes, Gaſcony, France	43 30 N	0 5 E
LONDON, Metropolis of England	51 32 N	0 0
Loretto, Tuſcany, Italy	43 36 N	0 59 E

Louvain,

	Latit. D. M	*Dif.Mer.* H.M
Louvain, Spaniſh Provin.	50 40 N	0 19 E
Lubeck, Holſtein, Denmark	54 10 N	0 45 E
Lublin, Poland	51 18 N	1 40 E
Lucca, Tuſcany, Italy	43 50 N	0 44 E
Lucern, Switzerland	46 42 N	0 34 E
Lugo, Gallicia, Spain	42 50 N	0 27 E
Lunden, Gothland, Sweden	55 30 N	0 54 E
Luxemburgh, Saxony, Germany	53 10 N	0 43 E
Luxemburgh, France	49 20 N	0 25 E
Lions, Lionois, France	45 40 N	0 19 E
M.		
Madagaſcar, Africa	19 29 S	2 56 E
Madrid, New Caſtile, Spain	40 10 N	0 14 W
Maeſtricht, Spaniſh Provinces	50 34 N	0 23 E
Magdeburgh, Saxony, Germany	51 45 N	0 50 E
Majorca, in the Mediterranean	39 0 N	0 10 E
St Maloes, Bretagne, France	48 38 N	0 9 W
Malaga, Granada, Spain	36 0 N	0 16 W
Malta, near Sicily, Mediterranean	35 50 N	0 56 E
Malacca, Eaſt-Indies	2 8 N	6 42 E
Mans, Orleanois, France	48 5 N	0 1 E

CHAP. XXIV.	*Latit.* D. M N	*Dif. Mer.* H. M
Mansfield, Saxony, Germany	51 20 N	0 48 E
Mantua, Italy	45 16 N	0 47 E
Manfredonia, Naples, Italy	42 5 N	1 6 E
Marpurg, Germany	50 30 N	0 35 E
Marseilles, Provence, France	43 15 N	0 23 E
Masa or *Massa*, Tuscany, Italy	44 0 N	0 43 E
Meaux, Isle of France	48 54 N	0 11 E
Mecca, Arabia Felix	21 30 N	2 34 E
Mechlin or *Malines*, Spanish Provinces	50 50 N	0 9 E
Medina, Arabia Felix	24 15 N	2 22 E
Medina-Sidonia, Andaluzia, Spain	36 8 N	0 21 W
Meissen, Upper Saxony, Germany	50 32 N	0 54 E
Mentz or *Mayence*, Germany	49 44 N	0 33 E
Merida, *Extremadura*, Spain	38 30 N	0 21 E
Messina, Sicily	38 10 N	1 3 E
Metz, Lorain, Germany	48 50 N	0 24 E
Mexico, North America	10 0 N	6 56 W
St Michael, see Arch-Angel		
Midnick, Samogitia, Poland	55 45 N	1 36 E

Milan,

	Latit. D. M	*Dif.Mer.* H.M
Milan, Italy	45 28 N	0 38 E
Minſki, Lithuania, Poland	54 6 N	1 53 E
Minorca Iſland, Mediterranean	39 10 N	0 16 E
Mirando, Portugal	41 10 N	0 23 E
Mittau, Courland	56 25 N	1 40 E
Modena, Italy	44 30 N	0 47 E
Montpelier, Languedoc, France	43 28 N	0 16 E
Mons, Spaniſh Provinces	50 20 N	0 15 E
Monſtiers, Savoy, Italy	45 6 N	0 26 E
Monaco, Genoa, Italy	43 45 N	0 30 E
Mondonedo, Gallicia, Spain	43 20 N	0 28 W
Morlaix, Bretagne, France	48 38 N	0 15 W
Moſcow, Capital of Muſcovy	55 30 N	2 38 E
Moulins, Lionois, France	46 30 N	0 13 E
Mouſol near Old Nineveh	34 32 N	2 52 E
Mulhauſen, Saxony, Germany	50 40 N	0 44 E
Munſter, Weſtphalia, Germany	51 45 N	0 31 E
Munchen or *Mimick*, Bavaria, Germany	47 45 N	0 46 E
Murcia, Spain	37 20 N	0 3 W
N.		
Namur, Flanders	50 10 N	0 23 E

Nancy,

Chap. XXIV.	*Latit.* D. M	*Dif.Mer.* H.M
Nancy, Lorrain, France	48 32 N	0 27 E
Nantz, Bretagne, Franc.	47 12 N	0 6 E
Nankin or Nanquin, China	31 0 N	7 54 E
Naples, Italy	41 45 N	0 59 E
Napoli di Romania	37 30 N	1 30 E
Narva, Livonia, Sweden	58 55 N	2 2 E
Narbonne, Languedoc, France	42 50 N	0 12 E
Naſſaw, Upper Rhine, Germany	50 0 N	0 32 E
Nevers, Orleanois, Fran.	46 50 N	0 13 E
Newbury, Suabia, Germ.	48 10 N	0 43 E
Newhauſel, Hungary	48 15 N	1 4 E
Newmark, Tranſylvania	47 30 N	1 26 E
Nice or *Nizza*, Piedmont, Italy	43 40 N	0 29 E
Nigepoli, Bulgaria, Turk.	45 10 N	1 46 E
Niſmes, Languedoc, France	43 30 N	0 18 E
Niſſa, Servia, Turkey	43 32 N	1 23 E
Norkoping, Gothland, Sweden	58 20 N	1 10 E
Notteburg, Ingria, Swed.	60 0 N	2 5 E
Novogrod, Weliki, Ruſſia	58 10 N	2 9 E
Nuremburg, Franconia, Germany	49 0 N	0 45 E
O.		
Ocrida, Albania, Turkey	40 18 N	1 18 E
Oleron, Gaſcony, France	43 0 N	0 1 W

Olmutz,

	Latit. D. M	*Dif.Mer.* H.M
Olmutz, Bohemia, Germany	49 32 N	1 10 E
St Omers, Flanders	50 50 N	0 9 E
Onſpack or *Anſpack*, Franconia, Germany	48 50 N	0 42 E
Orange, Provence, Fran.	44 10 N	0 19 E
Oran, Barbary, Africa	35 30 N	0 0
Orbitello, Tuſcany, Italy	42 15 N	0 48 E
Oreſca, ſee Notteburg		
Orenſe, Gallicia, Spain	42 10 N	0 29 W
Oricheda, Murcia, Spain	37 28 N	0 1 W
Orleance, Orleanois, France	47 45 N	0 7 E
Orvieto, Papacy, Italy	42 27 N	0 53 E
Oſnaburg, Weſtphalia, Germany	52 10 N	0 33 E
Otranto, Naples, Italy	40 52 N	1 15 E
Oudenard, Flanders	50 46 N	0 13 E
Oviedo, Aſturia, Spain	43 10 N	0 23 W
P.		
Padua, Italy	35 32 N	0 50 E
Paderborn, Weſtphalia, Germany	51 30 N	0 36 E
Palencia, Leon, Spain	42 0 N	0 17 W
Palermo, Sicily	37 26 N	2 30 E
Pampelona, Spain	42 30 N	0 5 E
Panama, America	1 10 S	5 30 W
Papoul, Languedoc, France	42 12 N	0 9 E
Paris, France	48 45 N	0 9 E

Parma,

CHAP. XXIV.

	Latit. D. M	*Dif.Mer.* H M
Parma, Italy	44 42 N	0 44 E
Paſſaw, Bavaria, Germ.	48 20 N	0 57 E
Pau, Gaſcony, France	43 15 N	0 1 W
S. Paul de Tricaſter, France	44 20 N	0 19 E
Pavia, Milan, Italy	45 12 N	0 38 E
Pekin, China	39 52 N	7 23 E
Perpignan, Catalonia, Spain	42 30 N	0 12 E
Pergamos, Natolia, Aſia	37 50 N	1 57 E
Perugia, Italy	42 48 N	0 51 E
Peſt, on the Danube over againſt Buda	47 0 N	1 8 E
Peter-Waradin, Sclavonia	45 0 N	1 11 E
Peterſburg, Ruſſia	59 25 N	1 59 E
Philipopoli, Romania, Turkey	42 30 N	1 39 E
Philadelphia, Natolia, Aſia	38 35 N	1 58 E
Pignerol, Upper-Dauphine, France	44 48 N	0 30 E
Piombino, Tuſcany, Italy	42 54 N	0 45 E
Piſa, Tuſcany, Italy	43 55 N	0 45 E
Placentia, Parma, Italy	44 50 N	0 41 E
Placenza, Biſcay, Spain	42 45 N	0 8 W
Plazentia, Extremadura, Spain	39 32 N	0 20 W
Pleſkow, Ruſſia	58 10 N	2 16 E
Ploozko, Poland	52 35 N	1 22 E

Poictiers,

	Latit. D. M	*Dif.Mer.* H.M
Poictiers, Orleanois, France	46 30 N	0 1 E
Policaſtro, Naples, Italy	40 18 N	1 5 E
Porto or *Oporto*, Portugal	40 52 N	0 31 W
Port Royal, Jamaica	17 40 N	5 4 W
Poſega, Sclavonia	45 25	1 2 E
Prague, Bohemia, Germany	50 0 N	0 58 E
Preſburg, Hungary	48 22 N	1 2 E
Q.		
Quebeck, Canada	47 10 N	4 41 W
St Quintin, Picardy, France	49 50 N	0 12 E
R.		
Raab or *Rab*, Bavaria, Germany	47 50 N	1 3 E
Raguſa, Dalmatia, Turkey	42 25 N	1 6 E
Ratiſbon, Bavaria, Germ.	48 34 N	0 49 E
Ravenna, Italy	44 25 N	0 51 E
Regio, Calabria, Italy	38 40 N	1 5 E
Rennes, Bretagne, Fran.	48 12 N	0 6 E
Rethel, Champagne, France	49 30 N	0 19 E
Reims, Champagne, Fr.	49 20 N	0 16 E
Rhodes Iſland, Archipelago	35 30 N	1 57 E
Riga, Livonia	57 0 N	1 39 E
Rochel, Orleanois, Fran.	45 55 N	0 3 E W

Chap. XXIV.	*Latit.* D. M	*Dif.Mer.* H.M
Rodes or *Rodes*, Guienne, France	44 12 N	0 11 E
ROME, Italy	42 8 N	0 52 E
Roſes, Catalonia, Spain	41 50 N	0 14 E
Roſienne, Poland	55 30 N	1 42 E
Roſanna, Naples, Italy	39 40 N	1 10 E
Rotterdam, Holland	51 50 N	0 17 E
Roven or *Roan*, Normandy, France	49 15 N	0 5 E
S.		
Saintes, Guienne, Franc.	45 45 N	0 2 W
Saltſburgh, Bavaria, Germany	47 20 N	0 54 E
Salamancha, Leon, Spain	40 45 N	0 19 E
Salonichi, Theſſalonica, Turkey	40 42 N	1 31 E
Saluces, Piedmont, Italy	44 30 N	0 30 E
Salerno, Naples, Italy	41 8 N	1 3 E
Sallee, Africa	22 25 N	0 31 E
Samarcaud, Tartary	40 0 N	4 15 E
Sandomir, Poland	50 20 N	1 33 E
Santillana, Auſtria, Spain	43 10 N	0 14 W
Saragoſa, Aragon, Spain	41 20 N	0 3 W
Saraio, Boſnia, Turkey	44 5 N	1 5 E
Sardis, Natolia, Aſia	38 10 N	1 56 E
Savona, Genoa, Italy	44 25 N	0 36 E
Scanderoon, ſee Alexandretta	37 10 N	2 31 E

Schaffhauſen,

	Latit. D. M	*Dif.Mer.* H.M
Schaffhauſen, Switzerland, Germany	47 28 N	0 35 E
Scopia, Servia, Turkey	42 20 N	1 25 E
Sculari, Albania, Turky	41 45 N	1 13 E
Sebenico, Dalmatia, Turkey	48 38 N	0 58 E
Segedni, Hungary	46 10 N	1 13 E
Segvia, Old-Caſtile, Spain	40 36 N	0 15 E
Sens, Champagne, Fran.	48 0 N	0 13 E
Setines, ſee Athens		
Seville, Andaluſia, Spain	37 0 N	0 20 W
Severin, Naples, Italy	39 25 N	1 10 E
Siam, Eaſt-Indies	14 5 N	6 43 E
Siena, Tuſcany, Italy	43 12 N	0 46 E
Sigel, Hungary	46 5 N	1 5 E
Siliſtria, Bulgaria, Turk.	45 6 N	1 42 E
Siradia, Poland	51 26 N	1 17 E
Siſteron, Provence, Fran.	44 15 N	0 24 E
Slezwick, Denmark	55 57 N	0 39 E
Smolenſko, Muſcovy	54 55 N	2 14 E
Smyrna, Natolia, Aſia	38 4 N	1 56 E
Soezaw, Moldavia, Turkey	47 30 N	1 39 E
Soiſſons, France	49 20 N	0 14 E
Sophia, Bulgaria, Turkey	42 32 N	1 30 E
Soraw, Bohemia, Germ.	51 35 N	1 1 E
Spalaha, Dalmatia, Turkey	43 20 N	1 2 E

CHAP. XXIV.	*Latit.* D. M	*Dif.Mer.* H.M
Spires, Upper-Rhine, Germany	49 0 N	0 33 E
Spoletto, Italy	42 28 N	0 55 E
Stetin, Pomerania, Germany	53 28 N	0 58 E
Stives, Achaia, Turkey	38 10 N	1 34 E
Stockholm, Sweden	59 30 N	1 16 E
Straſburg, Upper Rhine, Germany	48 17 N	0 31 E
Stugart, Suabia, Germ.	48 30 N	0 37 E
Sultzback, Bavaria, Germany	49 10 N	0 47 E
Surret, India	21 30 N	4 47 E
Syracuſe, Sicily	35 15 N	1 0 E
T.		
Tangier, Barbary, Africa	35 45 N	0 24 W
Targoviſco, Turkey	45 45 N	1 34 E
Tarante, Naples, Italy	40 40 N	1 11 E
Tarragon, Catalonia, Spain	40 55 N	0 5 E
Tavaſtus, Sweden	61 20 N	1 43 E
Tavira, Algarve, Portug.	36 46 N	0 29 W
Temeſware, Hungary	45 30 N	1 15 E
Tervel, Aragon, Spain	40 0 N	0 5 W
Tetuan, Fez, Africa	35 30 N	0 22 E
Thebes, ſee Stives		
Tholouſe or Tolouſe, Languedoc, France	43 15 N	0 7 E
Thorn, Poland	53 0 N	1 18 E
Thyatira, Natolia, Aſia	38 28 N	1 54 E

Tirol,

	Latit. D. M	*Dif.Mer.* H.M	CHAP. XXIV.
Tirol, Auſtria, Germany	46 15 N	0 43 E	
Tokay, Hungary	48 12 N	1 15 E	
Toledo, New-Caſtile, Spain	39 30 N	0 14 W	
Tortoſa, Catalonia, Spain	40 34 N	0 2 E	
Torneo or *Torno*, Lapland	65 50 N	1 34 E	
Tours, Orleanois, France	47 10 N	0 4 E	
Toulon, Provence, France	43 0 N	0 25 E	
Tournay, Flanders	50 35 N	0 14 E	
Trent, Auſtria, German.	45 50 N	0 46 E	
Trevigno, Italy	45 45 N	0 51 E	
Treves or *Triers*, Lower Rhine, Germany	49 30 N	0 27 E	
Tripoli, Barbary, Africa	33 5 N	0 55 E	
Troppo or *Troppaw*, Bohemia, Germany	50 15 N	1 12 E	
Troyes, Champagne, France	48 5 N	0 17 E	
Tudela, Navarre, Spain	41 45 N	0 7 E	
Tunis, Barbary, Africa	35 30 N	0 51 E	
Turin, Piedmont, Italy	44 50 N	0 31 E	
Tuy, Gallicia, Spain	41 50 N	0 33 E	
V.			
Valence, Dauphine, France	45 0 N	0 19 E	
Valencia, Valencia, Spain	39 15 N	0 1 E	
Valladolid, Old-Caſtile, Spain	41 28 N	0 15 W	
Vallona, Albemy, Turk.	39 56 N	1 12 E	
Vannes, Bretagne, Fran.	47 40 N	0 10 E	

CHAP. XXIV.	*Latit.* D. M	*Dif.Mer.* H.M
Vaudemont, Lorrain, Germany	48 18 N	0 26 E
Udine, Venice, Italy	46 10 N	0 54 E
Vendoſme, Orleanois, France	47 45 N	0 4 E
Vence, Provence, France	43 40 N	0 27 E
Venloe, Gelderland	51 10 N	0 25 E
Venice, Italy	45 36 N	0 51 E
Verdun, Lorrain, Germ.	49 10 N	0 21 E
Vercelli, Piedmont, Italy	45 35 N	0 34 E
Verona, Venice, Italy	45 25 N	0 48 E
Vic, Lionois, France	45 20 N	0 14 E
Vicenza, Venice, Italy	45 6 N	0 49 E
Viddin, Walachia, Turk.	44 20 N	1 26 E
Vienna, Auſtria, Germ.	48 12 N	1 7 E
Vienne, Dauphine, Fran.	45 26 N	2 43 E
Vitalio, Macedonia, Turkey	41 30 N	1 25 E
Vitoria, Biſcay, Spain	42 32 N	0 12 W
Viterbo, Papacy, Italy	42 18 N	0 53 E
Ulm, Suabia, Germany	47 55 N	0 41 E
Upſal, Sweden	59 55 N	1 14 E
Urbino, Italy	43 44 N	0 53 E
Uſcopia, Servia, Turkey	42 20 N	1 25 E
Utrecht, Holland	52 0 N	0 20 E
W.		
Warſaw, Poland	52 10 N	1 28 E
Waradin, ſee Peter-Waradin		
Warhuys, Norway	71 8 N	1 56 E

Waterford,

	Latit. D. M	*Dif.Mer.* H.M
Waterford, Ireland	53 0 N	0 29 W
Weimer, Saxony, Germ.	50 42 N	0 48 E
Weſel, Weſtphalia, Ger.	51 32 N	0 26 E
Weyſenburgh, Tranſylvania, Turkey	46 40 N	1 25 E
Wiberg, Jutland, Denm.	56 25 N	0 37 E
Wiborg, Finland, Swed.	60 50 N	2 0 E
Wihitz, Croatia, Turkey	45 0 N	0 57 E
Wiſbuy, Gotland, Swed.	57 30 N	1 20 E
Wittenbergh, Saxony, Germany	51 28 N	0 53 E
Wolfenbuttel, Brunſwic, Germany	51 50 N	0 43 E
Wormes, Germany	49 12 N	0 34 E
Wurtſburg or *Wirtſburg*, Francon. Germany	49 20 N	0 41 E
Y.		
Yvica, Mediterranean	38 40 N	0 5 E
Z.		
Zamora, Leon, Spain	41 15 N	0 21 E
Zara, Dalmatia, Turkey	44 0 N	0 56 E
Zalmar, Hungary	47 52 N	1 20 E
Zell, Lunenburgh, Germany	52 30 N	0 42 E
Zolnock, Hungary	47 5 N	1 13 E
Zurick, Switzerland, Germany	47 15 N	0 33 E
Zutphen, Gelderland, Holland	52 4 N	0 24 E

CHAP. XXV.

CHAP. XXV.

Concerning the Motion *of the* Hands *of a Clock or Watch, as it repreſents the* Motion *of the* Sun *and* Moon.

FOR a Concluſion of this Work, I ſhall here ſhew my Reader how naturally the *two* Hands of a *Clock* or *Watch* repreſent the Motions of the *Sun* and *Moon:* For as there are *Twelve* Calendar Months, and *Twelve* Signs in the Zodiack, ſo alſo are there *Twelve* Hours upon the Dial Plate of a *Clock* and *Watch.* But as the *Moon* makes *Thirteen* Conjunctions with the *Sun* in *one* Year, that is in the Time the Sun *apparently* moves once round the Heavens, ſo the *Minute-Hand* of a Clock or Watch makes but *Eleven* Conjunctions with the *Hour-hand* in the Time it moves *once* round. For let the *Hour-hand* repreſent the *Sun*, and the *Minute-hand* the *Moon*, at 12 *a-Clock* they are *always* together, then they both moving forward, when the *Minute-hand* comes again to 12, it doth not find the *Hour-hand* there, but is moved *One Eleventh* Part of the whole Revolution further; therefore the *Minute-*

Minute-hand must go 5′ 27″ 16‴ 21ⁱᵛ 49ᵛ $\frac{1}{11}$ before it makes the *next Conjunction* with the *Hour-hand*. And CHAP. XXV.

Just so it is with the *Sun* and *Moon*; for supposing the *new Moon* to be upon the 10th Day of *March* in the very beginning of *Aries*, they both moving forward according to the order of the Signs.

When the *Moon* comes again to the very *beginning* of *Aries*, she doth not find the *Sun* there, he is moved 26° 55′ 46″ more to the *East* in the *Ecliptick* *, so that the next Conjunction of the *Sun* and *Moon* will be made in *Aries* 29° 6′ 25″ 12‴, according to their *middle Motions*, and the next or *second new Moon* would be made in *Taurus* 28° 12′ 50″ 24‴; the *Third* in *Gemini* 27° 19′ 15″ 36‴; the *Fourth* in *Cancer* 26° 25′ 40″ 48‴, *&c.* every *new Moon* exceeding the Place of the foregoing by 29° 6′ 25″ 12‴, but they do not move equally as doth the Hands of a *Clock* or *Watch*. Therefore the above *equal* Law of the *Sun* and *Moon* is not exactly observed, however, this may serve well enough to give an *Idea* of the *new Moons*, how it is nothing else but the passing of the *Moon* by the *Sun*, as the *Minute-hand* of a *Watch* doth by the *Hour-hand*, as represented by this Table.

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* See my *Uranoscopia*, Page 166.

CHAP. XXV.

A New *and* Correct *Table shewing the* exact *Time that the* Hands *of a Clock or Watch* meet *through* One Revolution, *or the whole* 12 *Hours upon the* Dial Plate *of a Clock*, &c.

No.	Hours	H.	M	″	‴	iv	v
1	1	1	5	27	16	21	49 $\frac{1}{11}$
2	2	2	10	54	32	43	38 $\frac{2}{11}$
3	3	3	16	21	49	5	27 $\frac{3}{11}$
4	4	4	21	49	5	27	16 $\frac{4}{11}$
5	5	5	27	16	21	49	5 $\frac{5}{11}$
6	6	6	32	43	38	10	54 $\frac{6}{11}$
7	7	7	38	10	54	32	43 $\frac{7}{11}$
8	8	8	43	38	10	54	32 $\frac{8}{11}$
9	9	9	49	5	27	16	21 $\frac{9}{11}$
10	10	10	54	32	43	38	10 $\frac{10}{11}$
11	12	12	00	00	00	00	00

EXPLANATION.

The first Column to the *left Hand* shews the Number *of Conjunctions* of the *Hour* and *Minute-hand*, the *second* contains the *Hours*, the *third* the exact *Times* of their *meeting*.

As for Example.

The *two Hands* are *together* at 12 a-Clock, and the *next Time* they will be *together* will be at $5' 27'' 16''' 21^{iv} 49^{v} \frac{1}{11}$ past one, the *Third* meeting will be at $10' 54''$, *&c.* past 2, the *Fourth* at $16' 21''$, *&c.* past 3 a-Clock, *&c.* as in the Table, and this is plain enough without any more Examples.

CHAP. XXVI.

Of PAINTING *Sun* DIALS, *and first of the Planes or Surfaces on which* DIALS *are to be drawn.*

DIAL *Planes* are of *two* Sorts; *first*, such as are made on the Wall of a Building; or *secondly*, such as are drawn on Tables of Wood, vulgarly called *Dial Boards.*

The *first Sort* if they are made on *Brick-work*, is done by plaistering on the Wall with Lime, Sand and Hair, mixed; this must be well drenched with *Linseed Oil*, after it is dry, *i. e.* as long it will drink in any; and then painted with Oyl and white Lead, that it may be durable.

CHAP. XXVI.

But a better way is to temper the Lime, Sand and Hair with Ox Blood, which will be no great Charge; but of great advantage; for this Mixture will equal in Time the hardneſs of a free Stone, and keep the Surface as free from the Injuries of Weather; but you muſt afterwards paint it white. The following Method is ſtill preferable.

How to make an exceeding ſtrong Cement or Plaiſter *with which to form any Dial Plane upon the* Side of a Houſe *or* Wall, *which will endure the Weather, not inferior to Stone.*

Take *Lime* and *Sand*, and temper it with *Linſeed Oyl* to the Conſiſtency of *Mortar*, or common Plaiſter, and ſpread it upon the Wall to a *competent* Thickneſs, and it will become as hard as a Stone, and laſt many Ages; and upon this you may deſcribe a Dial, and put on the Lines, Figures and Furniture, as hereafter is directed.

Note, If you are in the Country, remote from any Opportunity of getting *Linſeed Oyl*, you may make it with *ſkimmed Milk*, which will be much ſuperior to Plaiſter made with Lime Hair, and Water.

If you are to draw a Dial upon a *Stone*, the beſt Way is to *drench* the Stone with *Linſeed Oyl* and *white Lead* mixt *very thin*, till

till it will drink in no more; then ſhall the *Dial* you paint upon it, laſt longer and be the better prepared againſt the Ruins of Time.

CHAP. XXVI.

Now for Tables or *Dial Boards* of *Wood*, they being the moſt common, I ſhall give ſuch Directions for making them, as have been always found moſt profitable and fit for the Purpoſe.

The beſt Woods for this Purpoſe, are the *cleareſt Oak* and the *reddeſt Firr*; provided it be not full of *Turpentine*; there is not much Difference between theſe Two Woods, as to their Alteration by the Weather; they being both ſubject to ſplit in caſe they *are bound*, and have not free Liberty to *ſhrink* with dry Weather, and *ſwell* with Wet, though as to their laſting, Oak ſeems preferable; tho' good red Firr will laſt the Age of an ordinary Man, if well ſecured, as Things of this Nature ought to be.

In working either of theſe kinds of Woods, the Boards ought firſt to be cut to ſuch a length as you intend your *Dial* Board ſhall be, and ſo many of them as may make up the Breadth deſigned, and let them be jointed on the Edges, and plained on both Sides, and afterwards ſet to dry.

For it has been obſerved, that though Boards have lain in a Houſe ever ſo long, and are ever ſo dry, yet when they are thus ſhot

CHAP. XXVI. *ſhot and plained, they will ſhrink afterwards beyond Belief, if kept dry.*

When you think they are dry enough and will ſhrink no more, let them be ſhot again with good Joints, and let every Joint be ſecured with wooden *Dove-Tails*, let in a-croſs the Joint in the *Backſide*; let this be done after the Boards are glued together and well dried: after it has been thus glued, and the Joints are ſufficiently dry, then let the *Face* of the Board be well plained and tried every Way that it may be both *ſmooth* and *true*, and the Edges ſhot true and all of a Thickneſs, as Pannels of Wainſcot are commonly wrought.

The *Edges* muſt be true and even, that they may fit into the *Rabit* of a Moulding, put round it, juſt as a Pannel of Wainſcot does in its Frame.

This Method will give Liberty to the Board to *ſhrink* without tearing; whereas Mouldings that are nailed round the Edges as the common Way is, do ſo reſtrain the Motion of the Wood, that it cannot *ſhrink* without tearing; but Boards made this Way will laſt a long Time, without either parting in the Joints or ſplitting in the Wood.

Dials are ſome times drawn on Planes lined with *Copper* or *Lead* that they may be free from ſplitting or tearing; but a Board *(if it be made as before directed)* is to be preferred in many Reſpects. As *firſt*, In that

that it is much cheaper. *Secondly*, Both *Lead* and *Copper* will ſwell a little with the Heat of the Sun, and in Time will grow *hollow outwards*, or convex inſtead of a perfect Flat, which will much pervert the Truth of its Shadow. And, *Thirdly*, The Colours will be apt to peel from the Metal, and the Dial will by that means be in danger to be ſooner defaced, than if it were painted upon a wooden Plane. CHAP. XXVI.

How to make the beſt Glue *for gluing the Joints of Boards for Dials.*

Take a *Quart of Milk* that has ſtood ſo long and been ſkimmed ſo often that no more Cream will ariſe; and when ſkimmed very clean boil it a little in a *Leaden Pot*, and if any ſkum yet ariſe be ſure to take it clean off; then put into the Milk about *half a Pound* of good Glue cut in ſmall Bits which will ſoon melt: boil it to *a good body*, but not to be too thick nor too thin; then take it off the Fire and keep it for Uſe. *Note*, Care muſt be taken in the boiling that it do not *burn to the Sides of the Pot*, for that takes away much of the Strength of the Glue; but if it be made with due Care, it binds beyond any other Glue, and it is better able to reſiſt the Weather, and therefore the fitteſt for gluing Boards for Sun Dials.

Care

CHAP. XXVI.

Care muſt be taken that your Glue be not made *too thin*, for if it be, the Wood will *ſo drink it up* that it will not be of *a ſufficient Body* to bind the Parts together; on the contrary, if it be *too thick*, it will not give Way for the Joint to *ſhut cloſe enough* to be ſtrongly joined; for though it is Glue that makes the Joints ſtick, yet where there is ſo much of it that the Joint cannot cloſe exactly, it will never hold firmly.

Wherever you uſe your Glue take Care that it *be thoroughly hot*, for Glue that is not hot never takes firm hold on the Wood.

You muſt alſo take great Care that the Boards you are to glue have not been *touched* with *Oyl* or *Greaſe*; for in ſuch Places the Glue will never take hold, altho' after a Thing is once glued faſt, no Greaſe nor Oyl can hurt it.

The Glue being ready, and the Joints of the Boards ſhot true, ſet *both* the Faces of the Joint cloſe together, and both alſo *turned upward*; then dip a Bruſh in the Glue and beſmear the Faces of both Joints *as quick as poſſible*, then clap the two Faces of the Joint together, and *ſlide or rub them long ways* one upon another two or three Times to ſettle them cloſe, and ſo let them ſtand till they are firm and dry.

CHAP. XXVI.

How to prepare your Oyl *for laying on the Colours upon Dials.*

Take *One* Gallon of *Linſeed Oyl* and ſet it upon a *Charcoal Fire*, and when it is about to boil put into it *Two Pound of Red Lead*, and let it boil together for *about an Hour*; but the beſt Way to know when it is boiled enough, is to take a little of it out, and let it cool, and then if it *ropes like thin Tar*, it is enough: This done put a *lighted Paper* to it, and ſet it on Fire to conſume the greaſy Part of it, which will be done in a Minute or two, more, or leſs, according to the Quantity of your Oyl; and when it has burnt *long enough* clap a Cloth or any other Thing cloſe over it, and extinguiſh the Fire; after which let it *cool* and *ſettle*, then decant the *clear Oyl* from the Dregs, and keep it *in a Bladder* for Uſe.

This is called *drying Oyl*, and with this the ſeveral Colours are to be ground in order to paint, ſo as *to endure the Weather*; but you muſt obſerve that your Colours are *thoroughly dry* before they are *expoſed*. The ſeveral Colours I ſhall deſcribe hereafter.

N.B. The *above Method* of making the *drying Oyl* has one Inconvenience in it, that it makes the Oyl of a *deep reddiſh Colour*, which in ſome Caſes may alter the *Nature* and

CHAP. XXVI.

Beauty, of ſome Colours, as *Whites*, which are liable to become *Yellow*; alſo *Blues* may by this means become *greeniſh*; to prevent which, *in the preparing of your Oyl*, inſtead of *Red Lead* uſe *Letharge of Gold*.

Of Colours *uſed in Painting* Sun Dials.

The Colours generally uſed in Painting Sun Dials are:

For *White*, Ceruſe and White Lead.

For *Black*, Lamp-Black, Ivory-Black, Charcoal, and Sea Coal-black.

For *Red*, Red-Lead, Vermillion and Cinnabar Lak.

For *Green*, Verdigreaſe.

For *Blue*, Indigo, blue Bice, blue Verditer and Smalt.

For *Yellow*, yellow Oker, and yellow Pink.

For *Brown*, Spaniſh Brown.

With the above Colours you may *compound* Variety of other Colours, *viz.*

An *Aſh Colour* is made by mixing a *little* Lamp-Black with White.

A *Purple* is made by mixing Cinnabar Lak and blue Bice.

A *Carnation* is made by mixing Cinnabar Lak and White.

A *Green*

A *Green* is made by mixing blue Bice with yellow Pink. *N. B.* Any Blue and Yellow make a *Green* of ſome Degree or other. CHAP. XXVI.

A *Light Blue* is made by mixing blue Bice and White.

A *Lead Colour* is made by mixing Indigo with White.

A lively *Graſs Green* is made by mixing Verdigreaſe with yellow Pink.

And by this means may ſeveral other Colours be compounded and made *lighter* or *darker* at Pleaſure, as a little Practice will make evident.

How to prepare *the Colours for painting Sun Dials.*

Before you proceed to the painting of Sun Dials in their ſeveral Colours, it is firſt neceſſary that they be *primed*, that is, painted *Two* or *Three* Times over with Oyl, and Colour prepared for that Purpoſe, to fill up the Cavities which may (after plaining) remain in the Wood, and to make it perfectly plain, and the more capable to receive and retain other Colours; and of all priming *Spaniſh Brown* is reckoned to be the chief; for, not to mention its Cheapneſs, it *dries kindly*, and gives the Oyl a ſufficient Time to penetrate into the Wood: and conſequently both reſiſts the Weather, and alſo freely receives all other Colours which

CHAP. XXVI.

which are laid upon it: it is of itſelf of a *Horſe-fleſh Colour*, and (beſides its Uſefulneſs in priming) it is a *natural Shadow* for *Vermillion*, and may be made lighter or darker, according to the greater or leſs Quantity of *White* mixt with it; tho' in *priming*, it requires not any Mixture, but only the Oyl itſelf.

In *preparing* the *Spaniſh Brown* for priming, grind it very well with the afore-mentioned *drying Oyl*, and make it for the *firſt priming*, ſomewhat *thinner* than you would do it for painting, that it may more eaſily penetrate into the Wood; which being dry, do it over a *ſecond Time* with the ſame Mixture, only mix it a *little thicker*; and letting that dry, do it a *third Time*, mixing your Colours *thicker* every Time; and take Care in the priming, not only to rub the Bruſh with the priming all over the Plane, both on the *Back*, as well as on the *Foreſide* and *Edges*, the better to preſerve it, but alſo to *bob* it againſt it, that the priming may be ſure to pierce into all the Cavities or Pores of the Wood: when this laſt Time of colouring with your priming is dry, then colour the *Face* of the Plane over with *white Lead*, and when it is dry do it over again *Three* or *Four Times* more ſucceſſively, after each drying; and ſo will the *Face* of your Plane be of a beautiful white Colour, and it will alſo be ſufficiently defended

fended againſt the Fury and Violence of the *Weather* for many Years, when the laſt colouring of your white is dry, your Plane is ready for laying on the Colours, *viz.* painting the *Hour Lines*, or what *Ornament* or *Furniture* you think fit to have upon it. CHAP. XXVI.

OBSERVE as a general Rule that priming is to be mixt or tempered *thin*, but Colours for Lines or Figures to endure the Weather, muſt be tempered *thicker*, the better to reſiſt the Fury of ſtormy or moiſt Weather.

If you are only for making a common *Sun Dial, theſe* four *Sorts of Colours will be ſufficient.*

1. *Spaniſh Brown*; which prepare, and therewith *prime* your Dial, as before directed.

2. *White Lead*, well ground in Oyl; with which, after the priming is *thoroughly dry*, go over it three or four Times, letting it dry between every Time; which not only makes a beautiful white ground, but fortifies it yet more againſt the Fury of the Weather.

3. *Lamp-Black*, for drawing the *Hour Lines* and *Figures*.

4. *Vermillion*, for drawing the *Parallels of Declination*, or what other *Furniture* you think fit to put upon it.

CHAP. XXVI.

The *Spaniſh Brown*, *Lamp-Black* and *Vermillion*, are all to be ground in the *drying Oyl*, deſcribed in Page 173; and for the *White Lead*, it is to be uſed in the ſame manner, only in making *drying Oyl*, for *White Lead*, inſtead of *Red Lead*, uſe *Litharge of Gold*, and proceed as before.

But if you would have your Dial more rich, you muſt firſt conſider, what Colours you reſolve to have your Lines, Figures, &c. to be, and *upon what ground* your determined Colours will appear moſt beautiful. As,

1. *Gold* appears beſt upon a *Blue* ground, and indifferently upon a *Red*.

2. *Blue* and *Green* appear beſt upon *Yellow* and *White*.

3. *Red* ſets off with *Yellow*, *White*, *Blue*, or *Green*.

4. *Yellow* ſets off with *Black*, *Blue*, and *Red*.

Beſides the Directions given already for *preparing* and *laying on* common Colours, it will be neceſſary to ſpeak of the *laying on* the more rich and beautiful Colours; and firſt of *Gold*.

How to make Gold Size, *with which you deſign to lay on Leaf Gold.*

Take *yellow Oker*, and grind it with *Water* on a Stone with a Muller, till it be *very fine*,

fine, and then lay it *to dry*, and grind it with the afore-mentioned *drying Oyl*, as you would grind other Colours, obſerving to put ſo much of each, that it may be of a *competent Stiffneſs* to work well, and of ſuch a Body, that it may ſettle itſelf ſmooth when laid on, but not *ſo thin* as to run; and take care to grind it *very fine*, and it will add the greater Beauty to your *Gold* that is to be laid on with it.

CHAP. XXVI.

How to lay on Leaf Gold, *or to make any Lines, Figures*, &c. *of Leaf Gold upon your Dial.*

Draw your Lines, Figures, or Letters, or what you think fit to have in Gold, with *Gold Size*, (abovementioned;) which dry ſo, that when you touch it with your Finger it will *ſtick*, but not *come off*; then cut your Leaf Gold as near as you can, into the Form you would have it, whether of Figures, Letters, Lines, &c. (taking Care to cut it rather *too large* than *too little*;) and with a flat Stick lined with Cloth, take up your Gold (ſo cut) and put it upon the Size, and the Gold will leave your lined Stick, and cleave to the Size; then *preſs it down* with *Cotton*, or a *Hare's Foot*, and take Care that you make the Figures, Lines, or Letters, in the *Gold Size*; and that you cut the Gold *large enough* to cover the Fi-

CHAP. XXVI.

gures ſo made in the Size; and when it is *thoroughly dry*, bruſh off all the looſe Gold, and the painting will remain beautiful, and be able to endure the Weather.

How to lay on Smalt *to make a* fine Blue.

When you have laid on what you think fit in *Leaf Gold*, take *white Lead*, mix it *pretty ſtiff* with *drying Oyl*, and with a Pencil lay that on where you intend your *Blue* ſhall be, and then put your *Smalt* in a *fine Searce*, and ſift it on to the Dial, and with a *Piece of Cotton*, dab it down upon the *White* before laid on, and when it is *thoroughly dry*, wipe off all the looſe Colour with a *Feather*, and blow off the Duſt with a *Pair of Bellows*, which will eaſily blow off all, except what fell upon the *White* before laid on to retain the *Blue*, which will be a very beautiful Blue.

Of the Nature *and* Colour *of ſome of the principal Ingredients uſed in painting of Sun Dials.*

1. CERUSE and *White Lead* are the only Colours to be uſed in painting in Oyl, and beſides their Uſefulneſs in painting of Dials, Paint made up with them and Oyl, is frequently made uſe of in painting Poſts, Paliſadoes, Gates, Doors, Windows, Wainſcoting, &c.

coting, &c. and anſwers the end of Painting, both as to Beauty and Preſervation, for they dry well, and ſtrongly reſiſt the Weather; and if you would have them *to dry* yet *more ſpeedily*, you may in *the tempering* put in a little *Oyl of Turpentine*, if it be *within Doors*; but *without Doors*, it is better without, becauſe that does not ſo well reſiſt the Weather. CHAP. XXVI.

2. *Lamp-Black* is a good Black, if it be firſt burnt, then ground, and laſtly tempered with Oyl.

3. *Charcoal* is a Black that will ſerve for ordinary Uſes; it *dries well*, but great Care muſt be taken that it be *well ground*.

4. *Spaniſh Brown*; the beſt is a *deep bright Colour*, and free from Stones, and being very well ground, is the beſt for priming: It is of a *Horſe Fleſh Colour*, and a *proper Shadow* for *Vermillion*.

5. *Red Lead* is a *great Drier* and *Binder*; for which Reaſon, it is made uſe of in the *drying Oyl*; it reſiſts the Weather as well as any Colour whatſoever.

6. *Vermillion* is a rich Colour, and of a good Body, but Care muſt be taken that it be finely ground, *even as ſoft as Oyl*, and then it will work extraordinary well: It is beſt to buy it *in the Stone*, leſt you meet with ſome that has been *adulterated* with *Red Lead*, or the like; it is a perfect Scarlet

CHAP. XXVI.

of itſelf, and may be altered to ſeveral Varieties, by mixing with other Colours.

7. *Cinnabar Lak* is a *rich Crimſon* Colour, and muſt be very fine ground.

8. *Smalt* is a very *fine Blue*, and it is beſt to *be ſtrewed* on, as before taught; for if you work it *in Oyl*, (though you waſh it, and mix it with white Lead) yet it will turn *black in Time*; if you buy it to work *in Oyl*, the *fineſt* is beſt, which is called *Oyl-Smalt*.

9. *Blue Bice* is a *pale Colour*, and works well though a little ſandy.

10. *Blue Verditer* is not ſo good a Blue as *Bice* and *Smalt*, though it may ſerve in Dial-painting where they are wanting; but it is a little ſandy, and apt to *fade* and *turn greeniſh*.

11. *Indigo* is a very *dark Blue*, and commonly lightned with White, when uſed in Painting, except in ſhadowing; it grinds fine, and is very proper for the *laſt Colour* of Poſts, Paliſadoes, Doors, Windows, *&c.* for it reſiſts the Weather, and preſerves the Wood.

12. *Blue Balls* are almoſt like *Indigo*, but not ſo good a Colour, nor will it endure ſo long.

13. *Umber* is a *Hair-Colour*, it muſt be very finely ground, which to effect, requires a great deal of Labour; it *dries* and *binds* exceedingly, and is therefore alſo very pro-

per for painting without Doors, as Doors, Paliſadoes; if calcined in a *Crucible*, it is a *natural* Shadow for *Gold*, and ſome other Colours. CHAP. XXVI.

14. *Verdigreaſe* is a perfect *willow green*, but may be altered at Diſcretion, with *Yellow*, &c. but being *very foul*; it muſt be mended or cleanſed, which may be thus done: *Grind it fine, and put to it* eight Times *its Weight of* Spirit of Vinegar, *digeſt till the Vinegar is tinged very green, then decant the Colour*; *caſt away the Fæces, and* evaporate *the Vinegar in a* Braſs Veſica, *ſo have you a very good Verdigreaſe at the Bottom, much more fine and valuable, than before it was cleanſed*; it dries very ſpeedily.

15. *Yellow Oker*, the *Engliſh*, the Colour of *freſh Wheat Straw*; the foreign is of ſomewhat *a more deep* Colour; it is much uſed in common painting, being ground very fine.

16. *Yellow Pink* is a *greeniſh Yellow*; it grinds well, and is good to mix with other Colours to make a *Green*.

Of theſe Colours ſome require *waſhing*, as *Red Lead, Blue Bice, Smalt* and *Verditer*, which is thus performed.

PUT the Colour into a glazed Veſſel, and put thereto plenty of clear Water, waſh it well, and (after a while) *decant* the Water; repeat this Work *Six* or *Seven* Times;

CHAP. XXVI.

at last (the Water being but just troubled) put it into another glazed Vessel, leaving the Dregs at the Bottom; then put some more Water into this second Vessel, and wash it as before, till the Water after settling be clear, and the Colour remain fine at the Bottom.

Note, Before you take the Colour out of the Vessel, *spread it* about the Sides of the Vessel *very thin*; and when it is dry, it will part of it fall down to the Bottom, which keep by itself, but that which sticks to the Sides of the Vessel is the best, and is as fine as any Flower; that strike off with a Feather, and keep it for Use.

The Colours that require *washing* being thus prepared, (or if they are those that do not require washing, they are done without) your next Work is *to grind them*, which is done thus:

TAKE *a* Spoonful or *two* of the Colour you intend to grind, and put to it a little *Linseed Oyl*, (but be careful you put in too little rather than too much;) mix them together, and upon your Stone with a Muller, grind them well, adding Oyl *by Degrees*, as you see it requires it, to make it like an Ointment, (always observing that it grinds much better when it is *thick*, than when it is *so thin*, as to run about the Stone;) every now and then scrape it up together

with a thin *Knife* or *Lanthorn-Horn* to keep it at or near the middle of the Stone, and ſo continue to work till you have ground as much as you have occaſion for; which done, clean your Stone by grinding *Sand* and *Water* upon it, and then waſh and dry it, and the Muller; and when you go to make Uſe of it, mix it with *drying Oyl*, till it be ſo thin as to *run freely* from the Pencil, yet ſo thick that the Ground may not *appear through* it, or to *run* when it is laid on, and then it will be the more beautiful Colour, and better endure the Weather.

CHAP. XXVI.

CHAP. XXVII.

The manner of Painting Timber Work.

BY *Timber Work* I mean all manner of Wainſcot, Doors, Windows, Poſts, Rails, Pails, Gates, Border-boards for Gardens, &c. to preſerve them from the Violence of Rain or Injury of the Weather; the Method of doing which, I ſhall here lay down as plain as I can.

Suppoſe then that there be a Set of *Paliſadoes*, or a *Pair of Gates*, or ſome *Poſts* and *Rails* to paint, and I would finiſh them

in

CHAP. XXVII.

in a *Stone Colour*; firſt look over the Work, and take Notice whether the Joints be open in the Gates, or whether there be any large *Clefts* in the Poſts; for if theſe are not ſecured, *the wet* will inſinuate itſelf into thoſe Defects, and make the quicker Diſpatch in rotting the whole Work: let the firſt Buſineſs therefore be; ſtop up theſe Places ſmooth and even with *Putty*, which is made of Whiting and Linſeed Oyl, well beaten together on the grinding Stone, or with a wooden Mallet, to the Conſiſtence of a very ſtiff Dough, and with this let all the Crannies, Clefts, and other Defects be perfectly filled up, that it may be *equal* to the Surface or Outſide of the Stuff; then proceed to the priming of the Work with ſome *Spaniſh Brown* well ground and mixed very thin with Linſeed Oyl; with this do over the Work, giving it as much Oyl as it will drink up; this in about *two* Days will be indifferent dry: then, if you would do the Work ſubſtantially, do it over again with the ſame priming Colour; when it is thorough dry, then take White Lead well ground and tempered up, but not *too thin*, for the *ſtiffer* you work it, if it be not too ſtiff, the better Body will be laid on; and the longer it will laſt: let this Colour be well rubbed on with a large Briſtle Bruſh, and the whole Surface of the Work be ſo intirely covered, that there remain no Crack

nor

nor Corner bare, which you may eaſily do by *jobbing* in the Point of a Briſtle Bruſh: Let this firſt Colouring dry, and then go over it a *ſecond* Time, and if you pleaſe a *third* alſo: the Charge will be a little more, but the Advantage will be great in the Duration. This Courſe is ſufficient for any kind of *Timber Work* that requires only a plain Colour, whether you thus cover the Work with a *Stone Colour*, or elſe with a *Timber Colour* in Umber and White, or a *Lead Colour* with Indigo and White, that with White being cheapeſt of the Three by much: nay I have known ſome lay over their Work only with a Coat of *Spaniſh Brown*, by tempering it up more ſtiff than was done for the two firſt Primings, which in ſome Reſpects is cheapeſt of all, and preſerves the Timber perhaps as well as any. Now he that is able to bring the Work thus far on, has proceeded to the higheſt pitch of that vulgar Painting, that aims at Preſervation beyond Beauty, tho' ſomething of Beauty is neceſſarily included in this alſo; but this is not all, for he that is arrived thus far, is in a fair Way to other Perfections in the Art of Painting; but for the Painting of *Wainſcot* with its proper Shadows, and for imitating *Olive* and *Walnut Wood*, *Marbles*, and ſuch like, theſe muſt be attained by too ocular Inſpection; it being impoſſible to deliver the Manner of the Operation by

CHAP. XXVII.

by Precept without Example, and I am bold to affirm, that a Man ſhall gain more Knowledge by one Day's Experience, than by an Hundred ſpent to acquire it ſome other Way.

I adviſe therefore all thoſe that deſire an Inſight into this Buſineſs, to be a little curious, if Opportunity offers, in obſerving the Manner of a Painter's working, not only in grinding his Colours, but alſo in laying them on, and working in them, in all theſe obſerving the Motion of his Hand, in the manage of any kind of Tool, and by this Means, with a little Imitation joined to the Directions here given, I doubt not but in a ſhort Time you may arrive to great Proficiency in the Buſineſs of vulgar Painting.

Note, That if when you have made uſe of your Colours, there be occaſion for a ſmall Ceſſation till the Work be finiſhed, in this Caſe it is beſt to cover the Colours, if any remain in your Pots with *Water*, for that will prevent their *drying*, even in the hotteſt Time.

And for your Pencils, they ought, ſo ſoon as you have done working, to be well waſhed out in clean Linſeed Oyl, and then in warm Soap-Suds; for if either Oyl or Colours be once dried in the Bruſh or Pencil it is ſpoiled for ever.

It

CHAP. XXVII.

It has been obſerved, that Timber laid over with *White*, when it has ſtood ſome Time in the Weather, the Colour will *crack* and *ſhrink* up together, juſt as Pitch does, if laid on any Thing that ſtands in the Sun; the Cauſe of this is the Colour's being laid on with *too ſtiff a Body*, for being wrought *too thick* once, it will dry with a *ſkin on the outſide*, which will keep the *inſide* moiſt and prevent its binding firm, from whence thoſe Cracks proceed.

Take notice, that if you ſhall at any Time have occaſion to uſe either Bruſhes that are very ſmall, or Pencils, as in many Caſes there will be occaſion, you ought then to diſpoſe of the Colours you uſe upon a *Pallet*, (which is a wooden Inſtrument eaſy to be had at any *Colour Shop*;) and there work and temper them about with your Pencil, that the Pencil may carry away the more Colour; for *you are to note*, that if a Pencil be only dipt into a Pot of Colour, it brings out no more with it than what hangs on the *Outſide*, and that will work but a little Way, whereas if you rub the Pencil about in the Colour, on a Pallet, a good Quantity of Colour will be taken up in the *Body of the Pencil*; and beſides all this, you may work your Pencils better to a Point on a Pallet, than you can do in a Pot; the Point of a Pencil being of greateſt Uſe in divers Caſes, eſpecially

CHAP. XXVII.

especially in drawing of Lines, and all kind of Flouriſhing.

I ſhall ſtill be more particular under this Head of Painting, becauſe Painters Work is very expenſive, and is the only Part in Building wherein a Gentleman can be aſſiſting either by himſelf or Servants, it being almoſt impoſſible for any Gentleman to do either Maſons, Bricklayers, Carpenters or Smiths Works, whereas it is now well known and experienced, that ſince the Advertiſement of *Alexander Emerton*, ſeveral Noblemen and Gentlemen have by themſelves and Servants painted whole Houſes without the Aſſiſtance or Direction of a Painter, which when examined by the beſt Judges could not be diſtinguiſhed from the Work of a profeſſed Painter.

And that which conduces moſt to this Practice is the vaſt Diſproportion between the Prices which Painters charge for their Work, and the Expence which Gentlemen are at in this Method of Painting, which at the utmoſt doth not amount to *one fourth* Part of the Painter's Price, to prove which I ſhall ſet down the Prices of Colours, and likewiſe ſhew what *Number of Yards* one Pound of each Colour will paint.

Firſt Primer ground in Oyl, at 36 *s. per* 112 *lb.* weight, or 4 *d. per lb.* One Pound of which will paint 20 *ſquare Yards.*

Second

Second Primer ground in Oyl, at 36 *s.* *per* 112 *lb.* weight, or 4 *d.* *per lb.* One Pound of which will paint 12 *ſquare Yards.*

Beſt White Lead ground in Oyl at 36 *s.* *per* 112 *lb.* or 4 *d.* *per lb.* One Pound of which, with two pennyworth of Oyl, will paint 8 ſquare Yards, which is three Farthings *per* Yard, for which Painters uſually charge 4 *d.* *per* Yard.

1. *Pearl Colour* ground in Oyl at 4 *d.* and 5 *d.* *per lb.*

2. *Lead Colour* ground in Oyl at 4 *d.* and 5 *d.* *per lb.*

3. *Cream Colour* ground in Oyl at 4 *d.* and 5 *d.* *per lb.*

4. *Stone Colour* ground in Oyl at 4 *d.* and 5 *d.* *per lb.*

5. *Wainſcot*, or *Oak Colour* ground in Oyl at 4 *d.* and 5 *d.* *per lb.*

N. B. *One Pound of any of theſe five Colours, with Oyl will paint eight ſquare Yards, for which Painters uſually charge* 4 d. per *Yard.*

1. *Chocolate Colour* ground in Oyl at 6 *d.* *per lb.*

2. *Mahogany Colour* ground in Oyl at 6 *d.* *per lb.*

3. *Cedar Colour* ground in Oyl at 6 *d.* *per lb.*

4. *Walnut-*

CHAP. XXVII.

4. *Walnut-tree Colour* ground in Oyl at 6 *d. per lb.*

N. B. *One Pound of any of these* four Colours *with Oyl, will paint* 10 *ſquare Yards, for ſome of which Painters uſually charge* 4 d. per *Yard, for others more.*

1. *Gold Colour* ground in Oyl at 8 *d. per lb.*

2. *Olive Colour* ground in Oyl from 8 *d.* to 12 *d. per lb.*

3. *Pea Colour* ground in Oyl from 8 *d.* to 12 *d. per lb.*

4. Fine *Sky Blue* mixed with *Pruſſian Blue* ground in Oyl from 8 *d.* to 12 *d. per lb.*

5. *Orange Colour* ground in Oyl at 12 *d. per lb.*

6. *Lemon Colour* ground in Oyl at 12 *d. per lb.*

7. *Straw Colour* ground in Oyl at 12 *d. per lb.*

8. *Pink Colour* ground in Oyl at 12 *d. per lb.*

9. *Bloſſom Colour* ground in Oyl at 12 *d. per lb.*

N. B. *One Pound of any of theſe nine Colours with Oyl, will paint eight ſquare Yards, for ſome of which Painters uſually charge* 10 d. *or* 12 d. per *Yard, for others they will expect more.*

Fine

Fine deep Green ground in Oyl at 2 *s.* 6 *d.* *per lb.* CHAP. XXVII.

N. B. *One Pound of which with Oyl, will paint* 20 *ſquare Yards, for which Painters uſually charge* 12 d. per *Yard.*

Oyls uſed in Houſe-painting are.

1. *Linſeed Oyl* at 10 *d. per* Quart.
2. *Turpentine Oyl* at 12 *d. per* Quart.
3. *Beſt drying Oyl* at 12 *d. per* Quart.

Painting Bruſhes of ſeveral Sizes from 2 *d.* to 6 *d.* each.

Putty at 4 *d. per lb.*

Double Size uſed by the Painters for priming new Work at 4 *s. per* Firkin, at 2 *d. per* Quart.

Single Size at 18 *d. per* Firkin, or 1 *s. per* Quart.

Theſe Colours, with all other Materials uſed in Painting, are prepared in the beſt manner, and ſold by ALEXANDER EMERTON, *Colourman*, at the *Bell* over againſt *Arundel-ſtreet* near *St Clement's* Church in the *Strand*, *London*. He likewiſe gives printed Directions for the uſing of his Colours, or procures Painters to work for Gentlemen by the Day, if required.

F I N I S.

To the ingenious Mr Charles Leadbetter.

SIR,

SInce no Perſon hath as yet ſolved the following Problem, which I propoſed * laſt *November*, I hope it will not be foreign to your preſent Deſign, to inſert it in your *Mechanick Dialling*, or *New Art of Shadows*, with its Solution, which if you think proper to do, you will very much oblige a Wellwiſher to the *Mathematicks*, and your ſincere Friend and humble Servant.

Kirkleatham, *Edward Hauxley.*
Feb. 1. 173$\frac{6}{7}$.

Problem.

It is required to know in what *Latitude* of this terraqueous Globe, an *Erect South Declining* Dial might be fixed to have theſe Properties, *viz.* the *Declination of the Plane*, *the Diſtance of the Subſtyle from the Meridian*, and *the Style's height* all *equal*, as alſo what Hours on *May* the 10th 1737, the Sun will *come on* and *go off* the Plane.

Solution.

Let $x =$ the Sine of the *Plane's Declination*, &c. and $y =$ the *Sine Complement* of the *Latitude* of the Place, by proceeding ſome few Steps, (when y is expunged) we have the following *Equation*, i. *e.* $x^4 - 3x^2 = -1$: By compleating the *Square* and extracting the *Biquadrite Root* thereof, when *half* the *Coëfficient* is duly *tranſpoſed*, x will be found $=$, 6187 $=$ the *Sine* of 38° : 13′ $=$ the *Plane's Declination*, &c. from whence y is alſo found $=$, 7876 $=$ the *Sine* of 51° : 58′ the *Co-Latitude*, hence the *Latitude* is 38° : 2′, and in *no other* Latitude is ſuch a Dial to be erected. From whence it is eaſy to find when the *Sun comes on* and *goes off* the Plane. *Q. E. D.*

N. B. Since the *Quality* of the *Latitude* was not mentioned in the Problem's Datas it may, therefore, be either *North* or *South*.

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* See the Monthly Oracle and Gentleman's Magazine for *November* 1736, Page 59.